SUGARBEET RESEARCH

1977 REPORT

A Report to and for
the Sole Use of Cooperators

NOT FOR PUBLICATION

F O R E W O R D

SUGARBEET RESEARCH is an annual compilation of progress reports concerning incomplete research by Science and Education Administration investigators and cooperators who are engaged in sugarbeet variety and production research. The report has been assembled by Dr. John S. McFarlane, Technical Advisor for sugarbeet breeding. The report has been reproduced at the expense of the Beet Sugar Development Foundation, and is for the sole use of the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. The report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor or contributors.

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Trade names occur in this report solely to provide specific information and do not signify endorsement by the U.S. Department of Agriculture or the Beet Sugar Development Foundation.

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SUGARBEET RESEARCH

1977 Report

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SUMMARY OF ACCOMPLISHMENTS, 1977

RESISTANCE TO WESTERN YELLOWS (BWYV)--Beet-free periods and other cultural practices have greatly reduced the incidence of BYV but not BWYV. BWYV still occurs commonly in beet fields and now is probably the most damaging component of virus yellows. The yellows breeding and evaluation program at Salinas has been designed to obtain breeding lines and hybrids resistant to the virus yellows complex, i.e., BYV-BWYV. As a consequence, little information is available on the potential damage caused by just BWYV or of the range in disease reactions in our breeding lines. In 1977, a composite of BWYV strains was used as inoculum. No inoculations were made with BYV and no BYV infection was detected in the test plots. Fortunately, little natural spread of BWYV occurred in our Salinas tests either before or after the inoculations. Contrasts between inoculated and noninoculated companion plots remained good throughout the season. In most previous years, western yellows infection has occurred in our noninoculated checks and our BYV-BWYV evaluations have probably been primarily for the differential effects of BYV infection.

The effects of BWYV infection are summarized in Tests 1277, 1377, 1477, 1577, 1877-1, and 1877-2. The results of these tests suggested that much of the yellows resistance observed under field conditions may be against BWYV. The measured sugar yield loss for C17 (417) in five tests varied from 0 to 12.1% with an average of 6.1% loss. Losses for 468 (US 75) and 464 (C64) in two tests averaged 22.7 and 24.7%, respectively. An increase of US 15 (Y523) showed a loss of greater than 30% in Test 1577, and a pollinator line not adapted to California, SP6822-0, had a loss of 40% in test 1877-1. In one test, F69-546H4 had a 20.7% reduction in sugar yield, whereas in another test, F70-546H3 had a loss of 14.5%. Even though on the basis of yield performance data, these tests would be rated as having good reliability, considerable variability, as usual was associated with estimates of sugar yield loss. Differences of 6 to 9% were needed to obtain statistically significant differences between varieties. Western yellows infection also had a substantial effect upon % sugar. For susceptible varieties, e.g., 468, 464, 546H3, etc., losses were in excess of 1 percentage point with a few approaching 2 percentage points loss. C17 averaged less than 1/2 percentage point loss.

Symptoms were more indicative of varietal reactions for BWYV than BYV or BYV-BWYV. With a few exceptions, e.g., too high ratings for Vytomo and other light green foliar types and too low ratings for NB1 and very dark green types which tended to mask symptoms, scores based on yellowing symptoms were correlated with sugar yield loss. These yellows evaluation tests show that considerable variability exists for resistance to BWYV and that hybrids with genotypes similar to C17 for yellows resistance would essentially eliminate BWYV as a production hazard. Because of the increased importance of resistance to BWYV relative to BYV, the yellows resistance program at Salinas was redirected in 1977. Breeding lines to be selected were inoculated with just BWYV rather than BYV-BWYV as in previous years. Emphasis on resistance to BWYV will be continued for several cycles of selection. Possibly without the confounding influence of BYV, the identification of resistant genotypes will be made more efficiently. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

CHOICE OF TOPCROSS TESTER--As monogerm breeding lines are developed from the disease resistance programs, the choice of combining ability testers is important. Because of the limited scope of the applied breeding program at Salinas, an ideal tester would be one that was used commercially but also one that would give unbiased combining ability information. For these reasons, C17 or similar pollinators, C13, C36, etc., would appear qualified. However, these pollinators have a relatively narrow base and some of the monogerm, type-O breeding lines now evolving in the yellows resistance program used C17, C13, or their sister selections as sources for resistance to yellows. A second consideration involved with testing type-O breeding lines, particularly self-fertile ones, is how to make the appropriate testcrosses. Insufficient outcrossing occurred with most of these $\underline{S}^f$ lines to permit use of a red beet (RY) tester. The use of 3-way hybrids with a common CMS line and topcross tester is technically easier than the use of single-cross hybrids. Also, from an experimental set of 3-way hybrids, it should be possible to predict the two monogerm components that would ultimately give the best yield.

Tests 877 at Salinas and B277 and B377 at Brawley were grown to obtain preliminary combining ability information particularly relevant to the disease resistance breeding programs at Salinas and possibly to other similar programs. C17 and C01 were chosen as testers. C17 was selected because of its wide commercial use and C01 was selected for its wider genetic base, greater diversity from the yellows resistant type-O lines to be tested, and for its potential value as a commercial pollinator. In the test at Salinas and the adjacent tests at Brawley, corresponding hybrids with C01 consistently had better performance for sugar and root yield, % sucrose, and resistance to rot but not for nonbolting tendency than did C17. In test 877, significant interactions between pollinators and females occurred for sugar yield (.05) and beet yield (.01). For root yield, the corresponding C01 and C17 hybrids were most similar when the type-O component and C17 were divergent and less similar when they had parentages in common. For example, lines C718, C546, C536, 701, and 788 are quite diverse from C17 whereas lines 703, 761-3, 778, 779, and 780 were derived from crosses between C17 type sources and curly-top resistant monogerms. These tests demonstrate the problem of using only one tester, in this case C17, for a combination of evaluations. If the use of C17 and similar genotypes as commercial pollinators is continued, experimental hybrids with C17 will need to be evaluated. However, to identify new, type-O, yellows resistant, monogerm lines for potential use with other pollinators, C17 may not accurately measure their combining ability.

In previous tests at Salinas and Brawley, it was found that the sugar yield of single-cross hybrids, e.g., C562HO x C17, C718HO x C17, C536HO x C17, etc., accurately predicted the 3-way combinations, e.g., (C562HO x C718) x C17, (C536HO x C718) x C17, etc. That is, the performance of 0.5[(C562HO x C17) + (C718HO x C17)] = (C562HO x C718) x C17. Through the use of this relationship, it is evident from tests 877, B277, and B377 that no 3-way hybrid combination of these monogerm lines would be superior to the single crosses of C718HO x C17 or C718HO x C01. Under low to yellows-free conditions, it also would appear that none of the new lines would be superior to the C718HO x C546 combination for the production of 3-way hybrids. Although not tested under yellows-infected conditions, the additional yellows resistance contributed from some of the new type-O lines would be expected to produce hybrids equal

to or superior to combinations involving C562, C546, C536, C718, etc. Of the newly developed type-O lines, 779 appeared to have the best combination of yield performance and disease resistance. Per se, this line is moderately resistant to virus yellows, curly top, bolting, and powdery mildew. Line 779 and several of the other type-O lines will continue to be reselected and evaluated. Tests also are continuing to determine the relationship between testers and type-O lines and between single crosses and 3-way hybrids. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

POPULATION IMPROVEMENT OF MONOGERM GERMPLASM--Unlike most multigerm, self-sterile breeding lines, recombination after each cycle of selection within monogerm, self-fertile (S^f), type-O breeding lines has been minimal and difficult to control. Thus most characters in self-fertile lines become rapidly and usually randomly fixed. To overcome this breeding limitation and to increase breeding flexibility, monogerm, type-O or near-type-O, random-mating populations have been developed within self-fertile sources. Genetic male sterility (a_1) has been incorporated to allow random mating. A number of these random-mating populations have been incorporated into the breeding strategies at Salinas. In 1977, one of these populations designated C789 and its CMS equivalent, C789 CMS, were released.

These populations are being used as sources for improving resistance to disease and particularly to develop germplasm with higher levels of multiple disease resistance, e.g., to combinations of virus yellows, curly top, *Erwinia*, powdery mildew, etc. In test 1477 at Salinas, 11 random-mating populations were evaluated for reaction to yellows in comparison to C17, 468(US 75), and 546H4. None were as resistant as C17, but most were more resistant to BWYV than 468 or 546H4. Repeated selections for yellows resistance should substantially improve the present levels of resistance. Yield performance of these lines per se was similar to the open-pollinated and F_1 CMS checks. Selection for resistance to *Erwinia* in two of these sources halved their susceptibility to soft rot.

The potential of several of the random-mating populations as monogerm seed-bearing parents was tested by crossing their CMS or near-CMS equivalents with C17 or C01 (Tests 977 at Salinas and B477 at Brawley). These broadbase or essentially synthetic hybrids had yield performance similar to US H10B. It can be anticipated that as these early generation populations are improved for disease resistance, adaption, and combining ability, that their hybrid performance will also improve.

A population designated 791 was used as the source for a breeding study to determine the effectiveness of recurrent selection for combined yellows resistance and yield. For two cycles of selection, half-sib families were evaluated for performance in replicated, BYV-BWYV infected field trials. In 1977 (Tests 1377 and 1177B), the first and second cycle synthetics were evaluated for yield under both noninoculated and BWYV infected conditions. Under the BWYV infected conditions, the comparisons among the C0, C1, and C2 synthetics showed that the selection procedure was effective in the identification of both higher and lower yielding genotypes. Without yellows, no differences occurred between the C0, C1, and C2 synthetics. Based on the sugar yield of C0 and C2, yield improvement was about 5% per cycle of selection under yellows conditions

but less than 1% per cycle under noninoculated conditions. Apparently, genotypes that moderate the reaction to virus yellows were selected by this procedure rather than by yield genes per se.

Progenies from line 791 were also evaluated and selected for sugar yield and % sucrose on the basis of S_1, full-sib, and test-cross performance under healthy conditions. Selections for amino nitrogen (NH_2-N), sodium (Na), potassium (K), and impurity index were made on the basis of S_1 performance. The first cycle synthetics were evaluated in 1976 (see 1976 Bluebook Report, pages A56-62) and 1977 (Tests 1177A, 1677, 1977-1, and 1977-2) at Salinas. In the 1977 tests of C1 synthetics, selection for sugar yield resulted in increases of about 7, 0, and 6% for the S_1, TC, and FS evaluations, respectively. Selection for % sucrose resulted in increases of % sucrose by about 2, 2, and 3% for the same evaluation methods. Selection on the basis of S_1 performance decreased NH_2-N, Na, and K concentrations by about 15, 25, and 15%, respectively. Selection for low NH_2-N increased Na and K by about 31 and 10%, respectively. Selection for low Na increased NH_2-N by about 43%. Selection for low K increased NH_2-N by about 16%. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

RESISTANCE TO ERWINIA--Breeding lines C36 and C02 were released in 1977 as potential Erwinia resistant pollinator lines to supercede C13 or C17. Both C36 and C02 were selected from C13. When C36 is used as the pollinator of 546H3, a hybrid with good resistance to Erwinia is produced. This hybrid has been tested under the experimental number E536H8 or C36H8. In comparison with US H10B at Salinas, Brawley, and in company trials during 1976 and 1977, C36H8 has been slightly superior for sugar yield. Its bolting tendency appears to be greater than US H10B's but is nearly equal to US H9B's. C36H8 is equal to US H9B in resistance to yellows but is more susceptible than US H10B. R. T. Lewellen, E. D. Whitney, and I. O. Skoyen.

VIRUS YELLOWS X ERWINIA--It has been repeatedly observed in comparisons between BYV or BYV-BWYV infected and noninfected companion plots and treatments that BYV infection significantly reduces the incidence of Erwinia soft rot counted at harvest. Usually in these tests, significant variety x virus yellows interactions for incidence of soft rot also occurred. However, in none of the 1977 virus yellows evaluation tests did BWYV infection cause a reduction in the natural incidence of Erwinia soft rot. Thus it appears that whereas BYV interferes or is antagonistic to Erwinia or the establishment of soft rot in sugarbeet, BWYV has no such effect. R. T. Lewellen and I. O. Skoyen.

FUSARIUM STALK BLIGHT RESISTANCE--Stalk blight resistant selections from the F_2 generation of a backcross of the susceptible C563 inbred to the moderately resistant NB1 inbred were evaluated in a Fusarium nursery at Salem, Oregon. All the selections were more resistant than 563 and several were superior to NB1. The best lines will be evaluated at Salinas in 1978 and seed increases are being made at Salem. Work thus far indicates that a resistant inbred, similar to C563, can be developed in a short period of time.

A group of 30 inbreds, open-pollinated lines, and hybrids were also evaluated at Salem in 1977. Damage ranged from almost none for the NB4 inbred to complete death for the 562 inbred (page A62). J. S. McFarlane.

RESULTS OF RUSSIAN TESTS WITH AMERICAN VARIETIES--Twenty-five American sugarbeet varieties were evaluated in four Russian field trials in 1975. Results of these trials were obtained from the Russians in October 1977 and are summarized on pages A63 to A67. The American varieties were less productive than the standard Ramon 06 and other adapted Russian varieties. Some of the American varieties were superior in Cercospora leaf spot resistance and others in virus yellows resistance. J. S. McFarlane.

GERMPLASM PRESERVATION--During the past 30 years more than 175 accessions representing all *Beta* species have been acquired and placed in storage at Salinas. This germplasm bank contains many genes for disease resistance and other desirable characters of value to the breeders. These accessions were inventoried and seed germinations determined in 1977. Seed increases were made of 60 accessions. Additional increases are planned for 1978. J. S. McFarlane and M. H. Yu.

INTERSPECIFIC HYBRIDIZATION STUDIES--Plants from a wide collection of wild beets including *Beta patellaris*, *Beta procumbens*, and *Beta webbiana* were tested for Cercospora leaf spot resistance. The results showed that most of these plants were not resistant to the pathogen. The transmission rate of nematode resistance through pollen of the resistant alien monosomic addition lines was estimated to be 0.03% (1 out of 3,645 plants). The meiotic behavior and the resistance transmission of a diploid nematode-resistant sugarbeet, selection 51501, have been studied (pages A56 - A58). M. H. Yu.

Emphasis was placed on selection for increased resistance transmission rate by both male and female gametes. The following conclusions may be drawn from the 1977 experiments: (1) Selection for a higher rate of resistance transmission slightly increased the rate of transmission in the F_3 generation. (2) The average rate of transmission by pollen was approximately one-half the transmission rate by female gametes. (3) Selection for transmission by pollen during two generations slightly increased the transmission rate from the F_1 to the F_3 generation. (4) The highest observed transmission rate by female gametes was 32.8% compared with 19.4% by male gametes (pages A59 - A60). H. Savitsky.

FIELD EVALUATION OF ROOT TOUGHNESS (ROOT FIBER CONTENT)--This quality characteristic, important to ease of processing sugarbeets, has received little attention during the development of other essential varietal attributes. A rapid method of surveying sugarbeet lines for root toughness has been developed by modifying the probe of a fruit firmness tester to a thin, flat blade. Resistance to blade penetration is measured as pounds pressure. 1977 preliminary test results indicated significant differences between and within varieties and also between seeding dates but not between root diameter and toughness. Further testing is needed to evaluate environmental effects but it should be possible to make selections for lower root fiber content. I. O. Skoyen and R. T. Lewellen.

YIELD COMPENSATION IN SUGARBEET INFECTED WITH CURLY TOP VIRUS--Second year data supports earlier findings (1976, pages A6, A75 "Sugarbeet Research" report) that, because of yield compensation by healthy neighbors, little yield loss occurred in sugarbeets inoculated with a severe strain of curly top virus when plants were young, if only 20-25% of the plants are infected. Over 90% total yield loss was observed in earlier tests with these same isolates with 100% infection. In 1977, the total yield loss was 66% for the 100% inoculation treatment (97% infection) with a severe strain of virus. Contrary to earlier findings, there were no significant effects from BCTV infection on sucrose content in 1977. Inclusion of a mild strain of BCTV in the 1977 test demonstrated that in a resistant variety, such as US H10, higher percentages of BCTV infection can be tolerated with a mild strain without loss in yield. No yield loss occurred with 56% infection with the mild strain.

The 1977 test indicated, as did the 1975 and 1976 tests, that the longer the incubation period after inoculation, before BCTV symptoms developed, the less damage or yield loss occurred. Apparently, little or no damage from BCTV occurs until after visible symptoms have developed. I. O. Skoyen and J. E. Duffus.

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1977

DUFFUS, JAMES E. The impact of yellows control on California sugarbeets. J. Am. Soc. Sugar Beet Technol. 1977. (In press)

A compilation of the sugarbeet production data in California from 1910-1974 shows some interesting trends and gives new insight regarding the economic impact of the yellowing viruses on sugarbeet. A statewide increase of 0.86 tons of sugar per acre for the last five growing seasons, attributed mainly to yellows control, has meant an increase of $217,969,000 received by farmers over this period. When the dollars generated by these yield increases are translated into general effects on the economy of the state, yellows control has contributed over $792,000,000 over this 5-year period.

DUFFUS, JAMES E. Serological relationships among beet western yellows, barley yellow dwarf, and soybean dwarf viruses. Phytopathology 67: 1197-1201. 1977.

The potential genetic vulnerability of substantial numbers of United States soybean cultivars to beet western yellows virus (BWYV), and the similarity of BWYV to soybean dwarf virus (SDV), a virus capable of inducing severe losses of soybean in Japan, led to serological studies between SDV and BWYV and other closely related viruses. Two antisera (from Japan) prepared against the dwarfing strain (SDV-DS) and the yellowing strain of SDV(SDV-Y) were tested against BWYV, turnip yellows virus (TuYV), beet mild yellowing virus (BMYV), and three isolates of barley yellow dwarf virus (BYDV). The virus-antiserum mixtures were subjected to density-gradient centrifugation and analyzed photometrically and by virus neutralization. Antiserum prepared against the SDV-Y and SDV-DS isolates of the SDV from Japan reacted with BWYV isolates from the United States and Europe, with BMYV from Europe, with TuYV from Europe, and with the RPV isolate of BYDV. The SDV antisera did not react with the MAV and PAV isolates of BYDV in a manner identical to the reactions of BWYV, TuYV, and BMYV antiserum with these two BYDV isolates. Neither saline nor antiserum to the beet yellows virus, or healthy shepherd's purse reacted with any of the virus isolates. Reciprocal tests with the SDV were not made.

DUFFUS, JAMES E. Beet free periods - the key to higher sugarbeet yields. Calif. Agri. 31(10): 18-19. 1977.

The yellowing virus diseases are serious hazards to stable production of beet and numerous other crops throughout the world. Since the dawn of agriculture, man has accepted these diseases as being induced by natural factors such as early ripening, drought, excessive moisture, nutritional deficiencies, or soil conditions. The implementation of beet free periods in California beet growing districts since 1968 has dramatically increased sugar production.

DUFFUS, JAMES E. and W. F. ROCHOW. Neutralization of beet western yellows virus by antisera against barley yellow dwarf virus. Phytopathology 68: 45-49. 1978.

A possible relationship between beet western yellows virus (BWYV), an extremely damaging virus of dicotyledonous plants, and barley yellow dwarf virus (BYDV), a virus of major economic importance in monocotyledonous grains and grasses was suspected on the basis of their biological properties.

Antisera prepared against the MAV, RPV, and PAV isolates of BYDV in New York were tested against four isolates (ST-1, ST-7, ST-9, and E-4) of BWYV in California. Virus-antiserum mixtures were subjected to density-gradient centrifugation, analyzed photometrically, and tested for virus neutralization. Antisera prepared against the three isolates of BYDV reduced or eliminated virus antigen in scanning patterns and reduced or eliminated virus in the normal BWYV-bearing zones. Antiserum against healthy shepherds purse or oat juice did not affect scanning patterns or infectivity. In contrast to the reaction of BYDV antiserum, none of 29 different antisera to 23 different viruses neutralized BWYV. In 5 of 14 tests Myzus persicae transmitted BWYV to oats (Avena byzantina). In 9 of 20 tests Macrosiphum avenae transmitted BWYV to shepherds purse. Inoculations of over 850 BWYV host plants failed to establish that the PAV, RPV, or MAV isolates of BYDV could infect them.

FALK, B. W. and JAMES E. DUFFUS. The first report of Polymyxa betae in the western hemisphere. Plant Dis. Reptr. 61:492-494. 1977.

Polymyxa betae, an intracellular parasite in the roots of sugarbeet (Beta vulgaris), was found in the Salinas Valley of California. This is the first report of the occurrence of this organism in the Western Hemisphere. The fungus has been reported as the soilborne vector of beet necrotic yellow vein virus and has been associated with rhizomania disease in Italy and Japan, but neither the virus nor rhizomania was found associated with P. betae in California.

FALK, B. W., JAMES E. DUFFUS and T. J. MORRIS. A helper-dependent aphid transmitted virus complex of sugarbeet and lettuce. Amer. Phytopath. Soc. Proc. 1977. (In press)

Lettuce speckles is a complex virus disease found in the Salinas and Pajaro Valleys of California. The disease produces small angular chlorotic flecks on the leaves of spring grown lettuce, Lactuca sativa L. Two viruses are associated with the complex. One is beet western yellows virus (BWYV) based on transmission, host range and serological properties. The other virus has not been completely characterized but appears to be previously unreported. It is mechanically transmissable to Nicotiana clevelandii Gray, where it produces a mild systemic mottle. This virus termed Lettuce Speckles Mottle Virus (LSMV) appears to be dependent upon BWYV, the helper virus, for efficient aphid transmission. The virus complex is transmitted by the green peach aphid in a persistent manner. Infectivity can be concentrated using conventional virus purification procedures. The infectious fractions contain a disease specific ds-RNA with a mol wt of 2.7×10^6 daltons.

FALK, B. W., JAMES E. DUFFUS and T. J. MORRIS. Two RNA species isolated from purified beet western yellows virus. Amer. Phytopath. Soc. Proc. 1977. (In press)

A highly virulent isolate (ST-9) of Beet Western Yellows Virus (BWYV) was shown to contain 2 species of RNA of approximately 1.9×10^6 and 0.85×10^6 daltons. By comparison, another leutovirus, Barley Yellow Dwarf (BYDV), previous shown to be serologically related to BWYV (Duffus and Rochow, 1973), has been shown by other workers to contain only a single RNA species of molecular weight 2.0×10^6 daltons. Thus, the presence of two RNA species in

BWYV was unexpected. BWYV was purified from shepherd's purse (Capsella bursa-pastoris L.). Leaves and stems were ground in an equal volume of buffer in a food grinder, homogenized in a Virtis "45" and squeezed through cheesecloth. The expressed sap was heated to 45 C. The virus was concentrated by differential centrifugation and further purified by 10-40% sucrose density gradient centrifugation. Nucleic acid was extracted from purified virus with phenol and SDS. Nucleic acid analyses, made by using disc polyacrylamide gel electrophoresis, revealed the presence of two species of RNA which based upon electrophoretic mobilities had estimated molecular weights of approximately 1.9×10^6 and 0.85×10^6 daltons.

HEIJBROEK, W., J. S. MCFARLANE and D. L. DONEY. Breeding for tolerance to beet-cyst eelworm Heterodera schachtii A. Schm. in sugarbeet. Accepted for publication in Euphytica (1977).

The sugarbeet nematode or eelworm is a serious pest in most of the older sugarbeet-producing areas of the United States. The pest is currently being controlled by crop rotation and by soil fumigation. Resistance to eelworm attack has not been found in the cultivated beet. This paper reports the results of a joint United States-Netherlands study aimed at the development of lines tolerant to wilting caused by the sugarbeet nematode. Wilt-tolerant lines were developed with improved root yields when grown in soils with moderate to severe nematode infestation. These lines are not resistant to nematode attack and would not prevent an increase in the soil nematode population. The use of wilt-tolerant varieties would need to be combined with crop rotation and/or chemical control.

LEWELLEN, R. T., E. D. WHITNEY and C. K. GOULAS. Inheritance of resistance to Erwinia root rot in sugarbeet. Accepted for publication in Phytopathology 68.

Increased susceptibility to Erwinia soft rot of sugarbeet (Beta vulgaris L.) was introduced inadvertently into commercial hybrid cultivars grown in California and Arizona. Two noninbred sugarbeet lines with different gene frequencies for resistance and susceptibility to infection by Erwinia were used as parents to study the inheritance of resistance. Individual roots from the parental lines and their F_1, F_2, B_1P_1, and B_1P_2 generations were grown and injury-inoculated in 2 yr of field testing at two locations. The difficulty of establishing maximum rates of infection in susceptible genotypes caused some problems in the interpretation of the data. On the basis of frequency distributions for resistant and susceptible roots in the segregating generations and in the progeny from resistant and susceptible selections, we concluded that resistance is simply inherited and primarily due to dominant gene action. A single dominant allele may be responsible for a high level of resistance in the root. The presence of a second, quantitative genetic mechanism that partially controls the rate of rot development within susceptible roots also was suggested.

MAGYAROSY, A. C. and J. E. DUFFUS. The occurrence of highly virulent strains of the beet curly top virus in California. Plant Dis. Reptr. 61:248-251. 1977.

Tests of isolates of the curly top virus collected during 1974 and 1975 from field beets and weeds in the foothills of the San Joaquin Valley indicate that the isolates have a higher degree of virulence than those found in the 1950's and the 1960's. Strains of increased virulence are apparently evolving

both in the foothill breeding grounds and in the agricultural areas. The hypothesis that severe isolates tend to be self-eliminating in the breeding grounds does not seem valid.

MAGYAROSY, A. C. and JAMES E. DUFFUS. Beet curly top virulence increased. Calif. Agric. 31(6):12-13. 1977.

During the last 20 years, numerous changes have occurred in the San Joaquin Valley ecology. Irrigation canals have been completed; more than 500,000 acres of uncultivated land have been brought under cultivation; and new agricultural chemicals, particularly herbicides, have been introduced. The entire cropping pattern of the valley has changed.

In light of these ecological changes, a reinvestigation of some aspects of the epidemiology of curly top disease has been long overdue.

REBOIS, R. V., ARNOLD E. STEELE, A. K. STONER, and B. J. ELDRIDGE. A gene for Rotylenchulus reniformis resistance and a possible correlation with Heterodera schachtii resistance in tomatoes. J. Nematol. 9:280-281. 1977.

Tomato seedlings from F_3 seed of a Lycopersicon pimpinellifolium (PI375937) x L. esculentum (Red Rock) cross were tested for reniform nematode (Rotylenchulus reniformis) resistance. F_3 seedlings derived from four of seven F_2 plants were all resistant, while those from another F_2 plant were susceptible. Progeny from two F_2 plants produced seedlings that segregated in a ratio of three resistant to one susceptible plant indicating there is at least one dominant gene (Re_1) for R. reniformis resistance in PI375937.

In addition to the progeny from the above seven parents, twenty-two other cultivars of different origin from five different countries were tested for resistance to both sugar beet nematode (Heterodera schachtii) and reniform nematode at Salinas, California, and Beltsville, Maryland, respectively. All cultivars responded similarly to both species of nematodes indicating the gene or genes that impart resistance to the reniform nematode may be the same or closely linked to those that cause resistance to the sugar beet nematode. Additional seedlings of the above segregating cultivars will have to be tested to determine if there is at least one dominant gene or other genes involved in H. schachtii resistance in tomatoes.

ROCHOW, W. F. and J. E. DUFFUS. Relationships between barley yellow dwarf and beet western yellows viruses. Phytopathology 68:51-58. 1978.

When concentrated preparations of the MAV or PAV isolates of barley yellow dwarf (BYDV) were tested against antisera of four isolates of beet western yellows virus (BWYV), no reactions occurred in any of several kinds of tests. But the RPV isolate of BYDV consistently reacted with antisera (diluted 1:5) for the E-4, ST-1, and ST-9 isolates of BWYV. Reactions were detected both in antiserum absorption tests assayed by sucrose density gradient centrifugation, and in infectivity neutralization tests assayed by the serological blocking of virus transmission by aphids fed on treated inocula through membranes. Similar results occurred when treated virus preparations were assayed by injection into aphid vectors. With about 12 µg of RPV isolate, a reaction was detected in tests with antisera for the E-4 and ST-9 isolates

of BWYV diluted up to 1:125. In comparative transmission tests, Myzus persicae occasionally transmitted the four isolates of BWYV to Coast Black oats. Transmission of the ST-9 isolate, for example, occurred in 4 of 5 experiments in which ST-9 was recovered from 11 of 23 inoculated oat plants, none of which developed symptoms. None of 128 attempts to transmit BWYV to oats by means of Rhopalosiphum padi or Macrosiphum avenae was successful, but M. avenae occasionally transmitted BWYV to shepherd's purse plants. None of 164 shepherd's purse plants became infected with the three isolates of BYDV. The relationship of the RPV isolate of BYDV to BWYV could have a special significance in epidemiology of these luteoviruses because of RPV's role as a helper virus in dependent virus transmission by aphids from mixed infections.

SAVITSKY, HELEN. Nematode (Heterodera schachtii) resistance and meiosis in diploid plants from interspecific Beta vulgaris x procumbens hybrids. Accepted for publication in Can. J. Genet. Cytol. (1978).

Three diploid nematode-resistant plants derived from hybrids between Beta vulgaris L. and B. procumbens Chr. Sm. were crossed with diploid nematode-susceptible plants. The rates of resistance transmission from the F_1 hybrids to the F_2 varied from 7 to 27%. The transmission rate of F_2 plants derived from F_1 plants with transmission rates over 20% averaged 20.9%. The rate for F_2 plants derived from F_1 plants with transmission rates of 10% or lower averaged 11.3%. In diploid plants nematode resistance was transmitted through the pollen at lower frequencies than through egg cells. Transmission through female gametes varied from 11.0 to 31.4% and through male gametes of the same plants from 0 to 19.7%. In some pollen mother cells (PMCs) of diploid nematode-resistant plants meiosis was normal and gametes derived from these cells transmitted resistance to the next generation. Abnormalities were observed in other PMCs, including the detachment of the B. procumbens segment from the translocated chromosome, the formation of bridges, and the lagging of broken translocated chromosomes. The inadequate transmission of resistance was caused by a loss of the B. procumbens segment in some B. vulgaris bivalents.

STEELE, A. E. Inheritance of resistance to Heterodera schachtii in Lycopersicon spp. J. Nematol. 9:285. 1977.

Twenty-eight cultivars or advanced breeding lines of L. esculentum, 22 accessions of L. pimpinellifolium, 4 accessions of L. peruvianum and 12 hybrids of L. esculentum x L. pimpinellifolium were evaluated for resistance to H. schachtii. Data established that resistance was variable within each of the three Lycopersicon spp. However, L. pimpinellifolium exhibited the greatest degree of resistance. Evaluation of F_1 and F_2 progeny revealed that resistance is conferred by a single dominant gene or that susceptibility is inherited as an epistatic combination of a single recessive and a single dominant (gene).

THOMSON, S.V., M. N. SCHROTH, F. J. HILLS, E. D. WHITNEY and D. C. HILDEBRAND. Bacterial vascular necrosis and rot of sugarbeet: general description and etiology. Phytopathology 67:1183-1189. 1977.

Vascular necrosis and rot of sugarbeet in California is caused by specific strains of the Erwinia carotovora group of soft-rotting pathogens which can be distinguished from members of the group on the basis of host reaction and biochemical tests. The bacteria invade the vascular tissue of the petiole

and roots and usually cause an extensive rot. Vascular bundles of infected roots are necrotic and areas surrounding the infected bundles turn pink upon exposure to air. The disease is found in most California sugarbeet plantings. The incidence of infection is usually 3-5%, but sometimes occurs in excess of 40%. Injury is necessary for infection, and temperatures of 25-30 C favor rapid disease development. Root yield was reduced from 76.8 metric tonnes/ hectare (ha) in control plots to 37.9 metric tonnes/ha in plots where plants were injured and inoculated when 8 wk old. Infections which occur early in the season are more important since the reduction in root and sugar yield was significantly greater when 8-wk-old plants were inoculated in the field than when 12 or 15-wk-old plants were inoculated. The pathogen also infected tomato and chrysanthemum plants in greenhouse inoculations and caused typical blackleg symptoms on potatoes grown at 18 C. Some strains of Erwinia carotovora var. atroseptica, Erwinia carotovora var. carotovora, and Erwinia chrysanthemi also infected sugarbeet. A few strains of the latter two species caused blackleg of potatoes in greenhouse tests at 18 C. Populations of the sugarbeet Erwinia sp. in soils planted to sugarbeets ranged from 2.1×10^2 to 2.8×10^6 colony-forming units/g of soil. Populations declined rapidly after harvest and the organism was not detected in soils throughout the winter. The Erwinia sp. was not isolated from sugarbeet seed.

WHITNEY, E. D. and R. T. LEWELLEN. Bacterial vascular necrosis and rot of sugarbeet: Genetic vulnerability and selecting for resistance. Accepted for publication in Phytopathology 68.

Field and greenhouse selections for resistance to an Erwinia species which incites vascular necrosis and rot of sugarbeet have shown high degrees of resistance following two cycles of selection. In all selections tested, resistance for the desired trait was increased. Resistance of hybrids with a selected population as one parent also showed an increase in resistance when compared with hybrids from the same seed parent and the susceptible pollinator parent. The greater vulnerability to Erwinia of the pollen parent of currently grown hybrid sugarbeet cultivars in California appeared to be the result of genetic drift. This drift is probably due to the use of too few plants to reconstitute the gene pool after each cycle of selection for virus yellows resistance.

YU, M. H. Preliminary study of pachytene morphology in a homozygous line of sugarbeet. Crop Sci. 17:833-836. 1977.

The morphology of the pachytene chromosomes of a homozygous Beta vulgaris L. line 6600 (2n = 18) was analyzed. Observations were made on squash preparations of alcoholic hydrochloric acid-carmine stained microsporocytes. Interpretation of the sugarbeet pachytene chromosomes was difficult because they failed to spread; nonetheless, the bivalents were distinguishable by the patterns of chromomere distribution. The physical lengths of the nine chromosomes were measured and found to range from 12.4 to 33.7 microns, with a total length of 214.3 microns. Based on the probable centromere positions observed, the complement consisted of three chromosomes with median centromere and six with submedian. The pattern of chromomere distribution of this species was nonproximal.

BOLTING AND VARIETY TRIALS, SALINAS, CALIFORNIA, 1976-77

Location: USDA Agricultural Research Station

Soil type: Sandy loam (Chualar series).

Previous crops: 1976-77 Sugarbeet test areas, Spence Field:
Block 1 - south, fallow 1974-1975; sugarbeet trials, 1973.
Block 2 - south, fallow 5 years.
Block 6, fallow 5 years

Fertilizer used: Preplant: Dolomite (equivalent to 105% $CaCO_3$), as needed, was broadcast at a rate of 1150 lbs/A and disced in about 6 inches deep. All test areas had 284 lbs/A 5:20:10 applied broadcast and chiseled in before listing in August 1976. Prior to seeding, 395 lbs/A ammonium sulfate was Bye Hoe incorporated into a 9-inch band on the beds.

Supplemental nitrogen: Two applications, as sidedressed ammonium sulfate at rate of 405 lbs/A, or 20% liquid N through sprinkler irrigation system at a rate of 475 lbs/A.

Total fertilization (lbs/A):

N	P_2O_5	K_2O
280	57	28

Summary: 1976-77 Tests in the Salinas Valley

Test No.	Sowing Date 1976-1977	Thinning Date 1977	Test Entries No.	Reps No.	Plot Rows No.	Plot Row Lgth. Ft.	Harvest Date 1977	Test Design
177	11/17	1/10-14	24	4	2	39	--	RCB
277-1	11/18	"	10	6	1	39	--	RCB
277-2	"	"	10	6	1	39	--	RCB
277-3	"	"	10	4	1	39	--	RCB
377	"	"	32	4	1	32	--	RCB
477-1	"	"	40	2	1	39	--	RCB
477-2	"	"	40	2	1	39	--	RCB
477-3	"	"	48	2	1	39	--	RCB
477-4	"	"	32	2	1	39	--	RCB
577	11/19	"	112	2	1	39	--	RCB
677	1/18	2/14-18	10	10	2	50	9/6-7	Latin Sq.
777	"	"	26	8	2	30	9/12-14	RCB
877	1/19	"	26	8	2	30	9/14-16	RCB
977	"	"	14	8	2	30	9/20-21	RCB
1077	"	"	32	4	1	30	--	RCB
1177	2/9	3/23-28	20	8	2	30	10/3-4	RCB
1277	2/10	"	18	8	1	30	9/21-22	Split-plot
1377	"	"	8	8	1	30	9/22-23	Split-plot
1477	"	"	14	8	1	30	9/28-29	Split-plot
1577	"	"	20	8	1	30	9/26-27	Split-plot
1677	3/22	4/25-29	16	8	2	39	10/4-6	RCB

Summary: 1976-77 Tests in the Salinas Valley (continued)

Test No.	Sowing Date 1976-1977	Thinning Date 1977	Test Entries No.	Reps No.	Plot Rows No.	Plot Row Lgth. Ft.	Harvest Date 1977	Test Design
1777	3/22	4/25-29	2	8	2	81	10/12	Split-plot
1877-1	3/21	"	7	6	2	25	10/6-7	Split-block
1877-2	"	"	7	6	2	25	10/6-7	Split-block
1977-1	5/3	6/8-10	8	8	2	25	10/26-27	Latin Sq.
1977-2	"	"	8	8	2	25	10/26-27	Latin Sq.
2077	"	"	1	5	5	13	10/17-19	Split-split-plot
2177	5/11	6/13	132	2	1	21	11/1-3	RCB

Inoculation dates (1977): Tests 1277 through 1577: April 28, with BWYV.
Tests 1877-1 and 1877-2: May 26, with BWYV.
Test 2177: July 21, with a suspension of Erwinia bacterium.

Irrigation: By either furrow or sprinkler system as required at 7-14 day intervals except during stand establishment when frequent light irrigations were used.

Diseases and insects: Natural virus yellows infection was very light throughout 1977, probably as a result of the aphid control provided by drought conditions and applications of Temik 15G. Twenty lbs/A was applied to Tests 177 through 1077 on April 20-21. Temik 15G was applied to Tests 1177, 1677, and 1777 May 18-19, 1977.

Inoculated tests 1277 through 1577 and tests 1877-1 and 1877-2 were sprayed with 1½ pints/A Meta Systox R on April 29 and May 27, 1977, respectively, for control of BWYV aphid vector.

Powdery mildew was moderately severe in 1977 where it was not controlled and occurred first in the earliest seeded tests. Spray applications of sulfur at 13-15 lbs/A between mid-June and mid-August provided good control of powdery mildew infection.

Natural infection of Erwinia soft rot was prevalent throughout tests. Some differential in root yield and % sugar may have been caused by soft rot. When observed, roots with soft rot were not used in sugar sample.

Sugar analysis: Determined from one or two samples per plot of approximately 10 roots each at the sugar analytical laboratory, U.S. Agricultural Research Station, Salinas, California.

Remarks: The assistance of Dr. F. J. Hills and Ms. Patricia Thomas, University of California at Davis, in the analysis of test data is gratefully acknowledged.

BOLTING AND POWDERY MILDEW RESISTANCE EVALUATION TESTS,
SALINAS, CALIFORNIA, 1977

Variety	Description	Bolting 8/31 %	Powdery Mildew[1/] 6/28 Score
TEST 177: 3 reps., RCB, 2-row plots, 39 ft. long, planted Nov. 17, 1976			
US H10B	546H3 x C17 (lot 3084)	2.1	6.0
464H8	F70-546H3 x F66-64	6.7	4.0
E506H8	F70-546H3 x E406-2,3,...	7.8	7.0
E536H8	F70-546H3 x C36	7.0	7.0
Y522H8	F70-546H3 x C22	4.5	7.0
617H72	C718H0 x C17	6.9	6.0
617H11	(C563H0 x C551) x C17	5.4	6.0
617H36	(C522H0 x C536) x C17	1.3	7.0
617H29	(C718H0 x C536) x C17	2.4	6.0
617H17	(C564H0 x C551) x C17	1.4	5.0
E637H8	F70-546H3 x E537	5.1	6.0
E638H8	F70-546H3 x E538	3.4	6.0
E639H8	F70-546H3 x E539	5.4	6.0
623-5H8	F70-546H3 x 523-5A	2.2	6.0
623-5H29	(C718H0 x C536) x 523-5A	3.7	6.0
Y617H72	C718H0 x Y517 (C16)	9.3	5.0
Y630H8	F70-546H3 x Y430	4.5	6.0
Y644H8	F70-546H3 x 4247	24.4	5.0
Y631H8	F70-546H3 x C31	5.7	4.0
Y631H72	C718H0 x C31	6.9	4.0
Y601H8	F70-546H3 x C01	9.0	5.0
Y601H29	(C718H0 x C536) x C01	10.7	5.0
Y601H72	C718H0 x C01	19.1	6.0
Y643H8	F70-546H3 x 5202	13.9	5.0
TEST 277: 6 reps., 1-row plots, 39 ft. long, planted Nov. 18, 1976			
617H72	C718H0 x C17	4.7	5.5
617H29	(C718H0 x C536) x C17	1.7	6.8
617HL8	(C718H0 x 5701) x C17	5.9	5.8
617HL9	(C718H0 x 5702) x C17	1.5	5.5
617HL10	(C718H0 x 5703) x C17	1.4	6.2
617HL11	(C718H0 x 5761-3) x C17	4.8	5.8
617HL12	(C718H0 x 5778) x C17	4.6	5.7
617HL13	(C718H0 x 5779) x C17	3.0	4.5
617HL14	(C718H0 x 5780) x C17	5.1	7.0
617HL15	(C718H0 x 5788) x C17	8.4	4.2
Y601H72	C718H0 x C01	18.0	5.5
Y601H29	(C718H0 x C536) x C01	4.4	6.5

1/ Powdery mildew scored from 0 to 9 (0 = no mildew, 9 = severe mildew).

BOLTING AND POWDERY MILDEW RESISTANCE EVALUATION TESTS,
SALINAS, CALIFORNIA, 1977 cont.

Variety	Description	Bolting 8/31 %	Powdery Mildew 6/28 Score
Y601HL8	(C718H0 x 5701) x C01	19.9	5.0
Y601HL9	(C718H0 x 5702) x C01	15.2	5.5
Y601HL10	(C718H0 x 5703) x C01	10.2	6.0
Y601HL11	(C718H0 x 5761-3) x C01	8.0	5.0
Y601HL12	(C718H0 x 5788) x C01	29.6	4.5
Y601HL13	(C718H0 x 5779) x C01	14.5	4.0
Y601HL14	(C718H0 x 5780) x C01	16.3	6.0
Y601HL15	(C718H0 x 5788) x C01	14.2	4.0
TEST 477: 1 rep., 1-row plots, 39 ft. long, planted Nov. 18, 1976			
464H8	F70-546H3 x F66-64	6.5	4.0
US H10B	546H3 x C17 (3084)	6.4	7.0
617H8	F70-546H3 x C17	2.6	6.0
617H31	3718H3 x C17	10.5	6.0
617H33	3546H72B x C17	5.0	5.0
617HL3	5742H3 x C17	7.3	6.0
Y601H31	3718H3 x C01	30.0	6.0
Y601H33	3546H72B x C01	18.2	6.0
Y601H37	Y417H0 (C16H0) x C01	20.0	5.0
Y601HL3	5742H3 x C01	18.8	7.0
Y631H29	3536-97H72 x C31	0.0	5.0
Y631H31	3718H3 x C31	6.5	5.0
Y617H8	F70-546H3 x Y517 (C16)	0.0	6.0
Y617H31	3718H3 x Y517 (C16)	4.3	6.0
Y643H29	3536-97H72 x 5202	21.7	6.0
Y644H29	3536-97H72 x 4247	14.6	6.0
Y645H8	F70-546H3 x 3204	59.0	4.0
E602H8	546H3 x C02	13.2	7.0
E606H8	546H3 x ERS E406	2.6	6.0
E634H8	546H3 x ERS E434	5.0	6.0
E637H31	3718H3 x E537	0.0	6.0
E638H31	3718H3 x E538	2.4	7.0
E639H31	3718H3 x E539	6.7	6.0
Y523H8	F70-546H3 x Y423	13.0	4.0
Y526H8	F70-546H3 x Y426	19.6	6.0
ACS-1	ACS S-72-301	37.5	4.0
-2	ACS 75-379	56.1	3.0
-3	ACS S-72-307	90.2	4.0
-4	ACH 121	81.4	5.0
Holly-1		66.7	4.0
-2		80.0	3.0
-3		92.5	3.0
-4		71.4	2.0

BOLTING AND POWDERY MILDEW RESISTANCE EVALUATION TESTS, SALINAS, CALIFORNIA, 1977 cont.

Variety	Description	Bolting 8/31 %	Powdery Mildew 6/28 Score
Sprex-1		2.2	7.0
-2		23.4	7.0
-3		5.9	5.0
F70-546H3	C562HO x F63-546	10.3	5.0
3546H72B	C718HO x F70-546	23.5	4.0
3718H3 (Sp.)	F66-562HO x C718	11.4	6.0
3705H72B	C718HO x C706	2.6	6.0
417 Ore.	Inc. 713A (C17)	2.7	7.0
617	Inc. 417 Ore.	7.0	6.0
623-5E (C23)	ERS 417-1	2.4	8.0
623-5 (Sp.)	Inc. 523-5A	0.0	8.0
Y617 (C16)	Inc. Y517-T-O Sel.	0.0	5.0
Y617HO (C16HO)	Y517HO x Y517-T-O Sel.	1.9	6.0
Y617-1	Inc. Y517-49 x 41	0.0	6.0
Y617-2	Inc. Y517-51 x 88	0.0	5.0
Y617 (Sp.)	Inc. Y517 (Iso.)	10.9	6.0
Y617HO (Sp.)	Y517HO x Y517	9.7	5.0
Y606	Inc. 4276mm	23.9	5.0
Y608	Inc. 4272mm	10.9	5.0
Y643	Inc. 5202	24.4	4.0
F70-13	Inc. F66-413 (C13)	6.8	7.0
E506 (Sp.)	Inc. E406, ...	21.1	5.0
E536 (C36)	Inc. E402, 5, 6, 34	20.5	5.0
E602 (C02)	ERS E402	4.5	8.0
E606	ERS E406	7.9	5.0
E634	ERS E434	15.0	7.0
E637	Inc. E537	4.9	6.0
E638	Inc. E538	2.6	7.0
E639	Inc. E539	0.0	7.0
Y646	ERS 4217	2.4	5.0
Y640	ERS Y440	15.4	4.0
Y641	ERS Y441	38.6	4.0
Y642	ERS Y442	21.2	5.0
Y522 (C22)	Inc. Y422	12.5	6.0
Y633	ERS Y233	8.1	7.0
Y601	Inc. Y401A (C01)	20.5	6.0
Y631	Inc. Y331 (C31)	2.3	5.0
Y631E	ERS Y231 (C31)	13.3	5.0
Y644	Inc. 4247	60.5	4.0
Y630	Inc. Y430	9.3	7.0

BOLTING AND POWDERY MILDEW RESISTANCE EVALUATION TESTS, SALINAS, CALIFORNIA, 1977 cont.

Variety	Description	Bolting 8/31 %	Powdery Mildew 6/28 Score
Y523	Inc. Y423	42.2	5.0
Y526	Inc. Y426	52.4	6.0
Y639	ERS Y439	21.2	5.0
Y645	Inc. 3204	93.3	4.0
Y645H37	Y417H0 x 3204	57.9	5.0
6224	Inc. 5244 Cb-	20.6	6.0
6225	Inc. 5245, 5246 Cb	25.0	6.0
5740	4740aa x A	28.6	5.0
5740H0	4740H2B x 4740	15.6	5.0
5741	4741aa x A	8.9	6.0
5741H0	4741H2 x 4741	14.3	6.0
6742	5742aa x A	10.2	6.0
6742H0	5742H2 x 5742	12.5	6.0
6742H2	5742H72 x 5742	8.2	6.0
5743	3791C1aa x A	3.9	6.0
6744	5744aa x A (C789)	11.3	7.0
6744H0	5744H0 x 5744 (C789H0)	13.5	7.0
6745	5745aa x A	8.2	7.0
6745H0	5745H0 x 5745	7.7	7.0
6755	5755,Baa x A	14.6	4.0
6755H0A	5755H2 x 5755,B	12.5	3.0
6755H0B	5755BH2 x 5755,B	6.0	5.0
4789	3789aa x A	14.3	4.0
6789	ERS 4789aa x A	2.2	5.0
4790	3790aa x A	8.9	5.0
6790	ERS 4790aa x A	2.3	4.0
5791F	3791-HGS(S_1)aa x A	4.7	6.0
5791I	3791-HS(S_1)aa x A	11.6	6.0
5791P	3791-LPMaa x A	27.9	5.0
6791	4791,Daa x A	14.0	5.0
6792,4(Sp.)	5792,4aa x A	6.7	5.0
6796-1	5796-1aa x A	14.6	6.0
6796-1H0	5796-1H2 x 5796-1	7.5	5.0
6796-2	5796-2aa x A	6.5	7.0
6796-2H0	5796-2H2 x 5796-2	6.7	7.0
3773	Inc. 1773a-HGS (C773)	20.9	4.0
3773D	Inc. 1773a-HS	29.4	6.0
6742H37	Y517H0 x 5742	14.9	6.0
6744H37	Y517H0 x 5744	10.5	6.0
6745H37	Y517H0 x 5745	20.0	6.0
6755H37	Y517H0 x 5755,B	15.9	5.0
6791H37	Y517H0 x 4791,D	8.2	6.0
6792H37	Y517H0 x 5792	21.2	6.0
6794H37	Y517H0 x 5794	4.3	7.0

BOLTING AND POWDERY MILDEW RESISTANCE EVALUATION TESTS, SALINAS, CALIFORNIA, 1977 cont.

Variety	Description	Bolting 8/31	Powdery Mildew 6/28
		%	Score
6796-1H37	Y417HO x 5796-1	12.5	5.0
6796-2H37	Y417HO x 5796-2	11.1	6.0
6742HL16	Y417H72 x 5742	10.9	5.0
6744HL16	Y417H72 x 5744	7.1	5.0
6745HL16	Y417H72 x 5745	4.0	6.0
6792H72 (Sp.)	F74-718HO x 5792	12.5	6.0
6794H72 (Sp.)	F74-718HO x 5794	9.4	5.0
6791H8	F70-546H3 x 4791,D	16.2	6.0
6791H31	3718H3 x 4791,D	14.3	5.0
5743H37	Y417HO x 3791C1	4.7	5.0
5756	4755aa x YR,MM,S[f]	15.2	5.0
F71-705	Inc. C705	76.2	4.0
F71-705HO	C705HO x C705	24.4	5.0
F74-718	Inc. C718	20.9	5.0
F74-718HO	C718HO x C718	21.1	5.0
3718 (Sp.)	Inc. 2718	17.1	6.0
3718HOA (Sp.)	1718HO x 2718	6.5	6.0
6706	Inc. 4791C1mm	17.4	4.0
6708	Inc. 4708	0.0	3.0
6713	Inc. 4713	6.8	6.0
6719	ERS 4717	0.0	5.0
6730	Inc. 4730	37.1	6.0
6731	Inc. 4731	10.5	6.0
6733	Inc. 4733	2.4	6.0
6736A	Inc. 4736	0.0	6.0
6737A	Inc. 4737	25.0	4.0
6746	5791I,K,F,B,H,J mm⊗	50.0	7.0
6756	Inc. 5756	37.0	6.0
6758-1	Inc. 4758-1	2.4	4.0
6758-3	Inc. 4758-3	8.9	5.0
6770A	Inc. 4770	2.6	4.0
6789A	ERS 4789	4.4	5.0
6790A	ERS 4790	6.8	4.0
6792A	Inc. 5792-T-O Sel.	20.8	4.0
6792	Inc. 5792-T-O Sel.	0.0	3.0
6793	Inc. 5793-T-O Sel.	7.1	6.0
6794A	Inc. 5794-T-O Sel.	19.5	6.0
6794	Inc. 5794-T-O Sel.	2.4	6.0
6795	Inc. 5795-T-O Sel.	26.9	5.0
6798	Inc. 5798-T-O Sel.	5.0	4.0
2512	NB 6	0.0	4.0
5205	Inc. 6600	100.0	8.0
F66-563HO	563HO x 563	38.9	5.0

BOLTING AND POWDERY MILDEW EVALUATION TEST
SALINAS, CALIFORNIA, 1976-77
(Test 577)

2 replications
1-row plots, 39 ft. long

Planted: November 19, 1976

Variety	Description	Bolting %	Powdery Mildew Grade 1/
517TH36	3536-97H23 x 117T	0.0	5.5
634 biloc.	aamm S.st. x 813	0.0	5.0
F75-536H1	522-29H23 x 536-97	0.0	6.0
517H29	3536-97H72 x 417	1.1	5.0
517H12	546H4 x 417	1.2	4.5
517H17	8551H4 x 417	1.2	4.5
517TH29	3536-97H72 x 117T	1.2	5.0
417H21	536-97H0 x C17	1.2	6.0
617H11	8551H4 x 417	1.2	5.0
617H17	551H5 x 417	1.2	5.5
604-23	Inc. 404-23 CTRS	1.2	4.0
534	Inc. (aamm S.st. x 813)	1.3	4.5
4547H1	502H0 x 547	1.7	4.5
417H28	536-97H3 x C17	2.2	6.0
6522-29H1	5522H1 x 5522-29	2.2	6.0
4554H4	3565H0 x 2554 (Iso.)	2.2	3.5
517TH17	8551H4 x 117T	2.5	5.0
F71-17	Inc. F70-17	2.5	5.0
517H36	3536-97H23 x 417	2.7	6.0
6551H4	563H0 x 5551	3.2	4.5
585	Type O S.st.	3.6	5.0
517T	Inc. 117T	4.6	5.0
Y003	Yellows resistant line	4.7	4.5
F75-536H4	563H0 x 536-97	5.0	5.5
5564H1	(502H0 x 562) x 564	5.0	5.0
517H8	546H3 x 417	6.0	4.5
604-13	Inc. 404-13 CTRS	6.4	6.5
464H8	US H7A	6.6	4.0
U617H17	551H5 x C817	6.6	5.0
517TH12	546H4 x 117T	6.9	5.0
617H36	5536-97H22 x 417	6.9	6.0
4554H1	NB1 x NB4	6.9	3.5
3536-97H72	718H0 x 536-97	7.6	5.0
504-6	Inc. 404-6 CTRS	7.9	6.5
464H2	US H6	8.6	4.0
6564H1	(2502H0 x 2563) x 564	8.9	5.5
464	Pollinator line	9.5	3.0
Bush Mono	Bush-Johnson variety	9.9	4.0
Vytomo	Swedish variety	10.1	4.5
3536-97H3	562H0 x 536-97	10.3	5.0

1/ 0 = No mildew   9 = Severe mildew

BOLTING AND POWDERY MILDEW EVALUATION TEST
SALINAS, CALIFORNIA, 1976-77
(Test 577)

2 replications
1-row plots, 39 ft. long — Planted: November 19, 1976

Variety	Description	Bolting %	Powdery Mildew Grade[1/]
5551H21	3536-97HO x 8551	11.0	4.5
921	Composite of Type O's	12.5	4.0
2522-29H23	522-25HO x 522-29	14.4	5.0
5551H17	8551H4 x 8551	15.2	4.0
3522-25H85	536H61 x 522-25	16.2	6.0
604-15	Inc. 404-15 CTRS	21.1	4.0
F66-569H3	562HO x 569	22.3	4.5
504-9 Iso.	Inc. 404-9 CTRS	23.2	6.5
5551H5	564HO x 8551	24.7	4.0
636aa	(aamm S.st. x Aamm S.st.) x (aamm S.st. x 813)	26.3	5.0
5522-29H21	3536-97HO x 4522-29	28.5	6.0
Y204	Inc. Y104A,B	30.4	5.5
F66-546H3	562HO x 546	35.7	4.5
5942	Inc. RW 880	52.0	4.0
AC 10	American Crystal hybrid	72.6	3.0
FC 3	69-9440	80.8	3.5
GW D2	Commercial hybrid	81.8	5.0
S72-315	American Crystal hybrid	83.7	3.0
AC 5	American Crystal hybrid	86.5	3.0
Yugo 89	4n line	93.4	3.5
5941RS	Inc. Yaltushkovsk mm	93.6	4.0
UI 8	Commercial hybrid	96.7	7.0
Am 7	Amalgamated variety	98.8	6.5
Inbred			
2512	NB 6	0.0	4.0
6512	S_{16}(US 22/3 x 4200-14)	0.0	3.5
6508	(2536aa x 3502Aa) x (2561aa x 3536-97)	0.0	5.0
6510	Inc. 2502aa x 1565	0.0	5.0
F75-536HO	536-97HO x 536-97	0.0	5.0
2547	NB5	0.0	3.0
2554 Iso.	NB4	0.0	2.0
6551	Inc. 551	0.0	3.5
6101	(2563aa x 3502Aa) x (2563aa x 2563)	1.6	5.0
6522-29	Inc. 5522-29	3.3	5.5
F75-536	Inc. 4536-97	3.6	5.0
6522-29HO	5522-29HO x 5522-29	4.5	5.5
6554	Inc. 0554	5.0	3.0
6507	Inc. 2563aa x 4502-1	5.7	5.0
5522-29HO	4522-25HO x 4522-29	5.8	5.5

BOLTING AND POWDERY MILDEW EVALUATION TEST
SALINAS, CALIFORNIA, 1976-77
(Test 577)

2 replications
1-row plots, 39 ft. long

Planted: November 19, 1976

Variety	Description	Bolting %	Powdery Mildew Grade[1]
F67-563H0	CMS of 563	6.4	4.5
5564	Inc. 4564C1	6.6	4.0
6551H0	551H17 x 551	6.8	3.5
3522-25	CTR inbred	7.2	5.5
5106Aa	2502aa x 4564C1	7.7	5.0
4536-97H0	CMS of 536-97	8.7	5.0
5505C2	S_1(2563aa x 1502 Iso.)	9.2	5.0
4536-97	CTR inbred	9.4	5.0
6554 (S_{14})	Inc. 2554 (Iso.)	9.7	2.0
5564Aa	4564aa x 4564C1	9.7	5.0
6505	Inc. 2563aa x 1502	10.3	5.0
6522-29 Iso.	Inc. 4522-29	10.5	5.5
F63-546	mm inbred	12.3	3.5
5564H0	4564H0 x 4564C1	13.3	4.0
4554	NB4	14.3	3.0
3565H0	564H0 x 1565	14.7	4.5
5522-29	Inc. 4522-29	15.4	5.0
5536-97RH0	3536-97H0 x 4536-97R	15.8	5.0
5506C2	S_1(2502aa x 1565)	16.8	5.0
5536-97R	Inc. 4536-97R	18.1	5.0
3565	Inc. 1565	18.4	4.5
6554C2	Inc. 4554	19.4	2.5
1502 Iso.	NB1	20.9	5.0
5551	Inc. 551	21.1	4.0
6562	S_{14}(4502 x 4570-49-12)	23.9	3.5
6503 (S_{18})	Inc. 5503	25.8	5.0
3592	Inc. 4592	25.9	5.0
2562	Inc. S_{11}(4502 x 4570-49-12)	28.3	3.5
F64-550	mm inbred	30.6	3.5
F66-562H0	CMS of 562	35.3	4.5
F66-569	mm inbred	36.6	4.5
F66-562	mm inbred	42.7	5.0
1502 Sp.	NB1	56.8	4.5
4539	NB8	68.4	6.0

TEST 677. HYBRID TEST, SALINAS, CALIFORNIA, 1977

10 x 10 Latin Square
2-row plots, 50 ft. long

Planted: January 18, 1977
Harvested: September 6-7, 1977

Variety	Description 1/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot 2/	Beets/ 100'	Bolting
		Pounds	Tons	Percent	Percent	Number	Percent
Y631H8	F70-546H3 x C31	11,700	40.57	14.44	3.6	128	0.2
Y601H8	F70-546H3 x C01	11,530	40.94	14.13	2.9	127	0.5
617H29	3536-97H72 x C17	11,400	41.43	13.79	10.5	130	0.0
517H12	F69-546H4 x C17	11,300	40.32	14.05	3.9	134	0.0
617H11	8551H4 x C17	11,160	41.58	13.44	7.6	130	0.1
E536H8	F70-546H3 x C36	11,100	39.53	14.09	0.7	125	0.4
US H10B	546H3 x C17 (3084)	11,080	39.68	13.99	4.5	126	0.1
E506H8	F70-546H3 x E406	11,080	39.55	14.02	0.7	121	0.1
617H17	F69-551H5 x C17	10,990	41.08	13.43	7.6	129	0.1
617H36	3536-97H22 x C17	10,840	39.18	13.86	11.0	127	0.1
Mean		11,220	40.39	13.92	5.3	127	0.1
LSD (.05)		421	1.46	.37	2.46	4.96	.33
Coefficient of Variation (%)		4.21	4.06	2.99	52.17	4.37	254.7
F value		3.1**	2.8**	5.6**	18.01**	3.49**	NS

1/ 546H3 = C562H0 x 546; 546H4 = C563H0 x C546; 3536-97H72 = C718H0 x C536; 8551H4 = C563H0 x C551; 551H5 = C564H0 x C551; 3536-97H22 = C522H0 x C536.

2/ % roots with Erwinia soft rot at harvest. Weighed but not included in sugar sample.

TEST 777. HYBRID TEST, SALINAS, CALIFORNIA, 1977

8 replications, RCB
2-row plots, 30 ft. long

Planted: January 18, 1977
Harvested: September 12-14, 1977

Variety	Description1/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot2/	Bolting	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Number
Y523H8	F70-546H3 x Y423	12,740	42.37	15.04	2.1	0.2	136
Y631H29	3536-97H72 x C31	12,510	43.76	14.30	11.5	0.5	130
Y644H8	F70-546H3 x 4247	12,420	43.00	14.48	3.9	2.6	122
Y601H29	3536-97H72 x C01	12,360	43.01	14.42	10.6	1.0	130
Y631H8	F70-546H3 x C31	12,280	42.02	14.62	5.5	0.2	129
Y526H8	F70-546H3 x Y426	12,080	39.99	15.14	1.9	1.7	133
Y601HL13	5779H72 x C01	12,080	41.95	14.40	12.0	0.5	131
617H29	3536-97H72 x C17	12,050	42.30	14.31	14.4	0.0	136
Y522H8	F70-546H3 x C22	12,000	41.60	14.43	2.9	0.3	135
Y601HL17	5796-1H2 x C01	11,940	40.15	14.88	11.0	0.8	138
E637H8	F70-546H3 x E537	11,860	40.27	14.74	3.9	0.0	133
Y601H8	F70-546H3 x C01	11,820	40.58	14.61	4.9	0.6	130
623-5H8	F70-546H3 x 523-5A	11,740	39.65	14.84	5.8	0.3	130
E506H29	3536-97H72 x E406,...	11,730	41.47	14.16	2.8	0.3	133
E536H29	3536-97H72 x C36	11,730	40.91	14.38	1.7	0.2	130
464H8	F70-546H3 x F66-64	11,670	39.29	14.88	1.0	0.5	127
Y601HL2	5741H0 x C01	11,640	39.61	14.70	7.9	0.3	128
Y643H8	F70-546H3 x 5202	11,600	40.05	14.53	4.9	8.5	135
US H10B	546H3 x C17 (3084)	11,550	40.26	14.36	5.8	0.2	131
Y630H8	F70-546H3 x Y430	11,550	40.96	14.14	2.4	0.8	133
Y617H31	3718H3 x Y517	11,530	40.90	14.12	8.5	0.0	129
617HL13	5779H72 x C17	11,490	39.00	14.73	10.0	0.0	131
617HL4	5744H0 x C17	11,440	39.00	14.68	13.5	0.0	123
617H8	F70-546H3 x C17	11,420	39.73	14.39	5.5	0.2	128
E638H8	F70-546H3 x E538	11,400	38.84	14.69	1.1	0.2	130
E639H8	F70-546H3 x E539	11,380	40.86	13.94	2.0	0.5	137
Mean		11,850	40.83	14.54	6.1	0.8	131
LSD (.05)		573	2.23	0.67	3.5	0.98	NS
Coefficient of Variation (%)		4.9	5.5	4.6	58.2	128.4	9.0
F value		3.4*	2.9*	NS	11.0**	22.7**	NS

1/ 546H3 = C562H0 x C546; 3536-97H72 = C718H0 x C536; 5779H72 = C718H0 x 779.

2/ % roots with *Erwinia* soft rot at harvest. Weighed but not included in sugar sample.

TEST 877. COMBINING ABILITY EVALUATION OF F_1 HYBRIDS USING C17 AND C01 TESTERS, SALINAS, CALIFORNIA, 1977

2 x 13 factorial in RCB, 8 replications
2-row plots, 30 ft. long

Planted: January 19, 1977
Harvested: September 14-16, 1977

Hybrid1/	F_1 Hybrid CMS x T-O	Sugar Yield/Acre x C17	Sugar Yield/Acre x C01	Beet Yield/Acre x C17	Beet Yield/Acre x C01	Sucrose x C17	Sucrose x C01	Root Rot2/ x C17	Root Rot2/ x C01	Bolting x C17	Bolting x C01	Beets/ 100'
		Pounds	Pounds	Tons	Tons	Percent	Percent	Percent	Percent	Percent	Percent	Number
H72	C718H0	12,940	13,200	46.35	45.86	13.96	14.38	10.7	7.5	0.0	1.1	130
H33	C718H0 x C546	12,720	12,710	44.17	43.97	14.40	14.47	10.3	6.7	0.2	0.5	132
H29	C718H0 x C536	12,590	12,770	43.70	44.25	14.42	14.44	18.2	8.4	0.0	0.0	132
H8	C562H0 x C546	11,970	13,290	41.74	45.51	14.36	14.64	6.4	6.2	0.0	0.3	134
HL10	C718H0 x 703	12,120	12,950	43.76	44.79	13.91	14.46	17.9	13.2	0.0	0.2	128
H31	C562H0 x C718	12,160	12,780	42.12	43.98	14.44	14.56	10.0	11.1	0.0	0.6	134
HL9	C718H0 x 702	12,090	12,580	42.76	44.30	14.15	14.20	26.5	15.6	0.0	0.3	127
HL15	C718H0 x 788	12,150	12,450	43.41	43.39	14.03	14.34	18.1	5.1	0.2	1.4	135
HL13	C718H0 x 779	11,560	12,980	40.51	45.05	14.29	14.44	17.4	15.8	0.0	0.6	130
HL8	C718H0 x 701	12,400	12,070	43.47	41.31	14.28	14.61	19.4	7.9	0.0	0.9	131
HL11	C718H0 x 761-3	11,700	12,760	42.14	43.68	13.90	14.61	16.3	9.6	0.0	0.5	135
HL14	C718H0 x 780	11,450	12,500	42.42	44.71	13.53	14.00	23.3	9.4	0.3	0.9	133
HL12	C718H0 x 778	11,320	12,310	39.00	42.68	14.52	14.48	11.1	6.9	0.0	2.2	135
Mean3/		12,090a	12,720b	42.74a	44.11b	14.17a	14.43b	15.8a	9.5b	0.1a	0.7b	132
LSD (.05)		609		2.23		NS		5.31		0.73		NS
C. V. (%)		5.0		5.2		3.7		42.6		192.0		7.1
F value for F x M		3.0**		2.8**		NS		3.4**		2.5**		2.0*

1/ Hybrid number. For example, (C562H0 x C546) x C17 and (C562H0 x C546) x C01 normally would be listed as 617H8 and Y601H8, respectively, for these seed increases.

2/ % roots with Erwinia soft rot at harvest. Weighed but not included in sugar sample.

3/ Means with a letter in common are not significantly different according to the F test.

TEST 977. EVALUATION OF BROADBASE HYBRIDS, SALINAS, CALIFORNIA, 1977

8 replications, RCB
2-row plots, 30 ft. long

Planted: January 19, 1977
Harvested: September 20-21, 1977

Variety	Description1/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot2/	Bolting	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Number
Y601HL18	5796-2H2 x C01	13,390	46.75	14.37	6.7	0.8	134
Y601HL1	5740H0 x C01	13,000	44.48	14.63	6.5	0.8	139
617HL2	5741H0 x C17	12,880	44.48	14.49	10.6	0.1	139
617HL1	5740H0 x C17	12,870	45.35	14.20	12.0	0.0	143
Y601HL3	5742H3 x C01	12,790	44.17	14.49	10.5	1.1	138
Y601HL2	5741H0 x C01	12,780	43.06	14.84	7.5	0.8	136
Y601HL17	5796-1H2 x C01	12,770	45.05	14.19	10.5	0.3	135
6794H37	Y517H0 x 5794	12,720	45.64	13.97	6.9	0.2	134
617HL7	5755BH2 x C17	12,710	44.60	14.28	13.1	0.0	137
US H10B	546H3 x C17 (3084)	12,700	45.21	14.06	7.3	0.0	141
617HL4	5744H0 x C17	12,390	42.96	14.48	12.0	0.7	142
617HL5	5745H0 x C17	12,350	43.15	14.31	11.1	0.0	139
Y601H37	Y417H0 x C01	12,270	43.28	14.18	10.9	0.3	133
6792H37	Y517H0 x 5792	12,230	44.33	13.80	16.3	0.8	133
Mean		12,700	44.47	14.31	10.1	0.4	137
LSD (.05)		NS	NS	0.52	4.4	NS	5.8
Coefficient of Variation (%)		5.8	6.3	3.7	43.8	200.0	4.3
F value		NS	NS	2.14*	3.3**	NS	2.4**

1/ 5740H0, 5741H0, etc. are CMS equivalents of near-type-O, self-fertile, monogerm, random-mating populations with varied combinations of resistance to yellows, curly top, bolting, etc. 5792 and 5794 are the pollen fertile phase of similar random-mating populations crossed to a CMS equivalent of C17 (Y517H0).

2/ % roots with *Erwinia* soft rot at harvest. Weighed but not included in sugar samples.

TEST 1277. (NONINOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MALES, FEMALES, AND THEIR HYBRIDS: PREDICTION OF REACTION TO YELLOWS, SALINAS, CALIFORNIA, 1977

Split-plot with 8 replications
2-virus treatments
1-row plots, 30 ft. long

Planted: February 10, 1977
Noninoculated
Harvested: September 21-22, 1977

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Root Rot[1/] Percent	Beets/ 100' Number
Males						
417	Inc. 713A(C17)	11,070	41.12	13.46	18.1	123
Y601	Inc. Y401A(C01)	12,700	45.22	14.07	2.9	117
464	Inc. F66-64(C64)	11,980	44.62	13.45	1.0	122
Females						
F70-546H3	C562H0 x C546	11,310	41.02	13.88	0.6	132
2718H5	C564H0 x C718	10,740	40.39	13.38	5.6	132
3718H54	C706H0 x C718	12,640	46.81	13.56	7.7	136
Hybrids						
617H8	546H3 x C17	13,180	49.65	13.32	7.7	132
Y601H8	" x C01	14,300	50.86	14.11	1.5	139
464H8	" x C64	13,820	49.84	13.89	0.6	134
317H80	718H5 x C17	14,230	53.34	13.40	4.4	134
Y301H80	" x C01	14,710	54.36	13.59	5.6	134
364H80	" x C64	13,430	49.90	13.53	1.4	131
417H82	718H54 x C17	13,280	48.56	13.67	10.5	127
Y301H82	" x C01	14,430	52.92	13.66	3.2	127
364H82	" x C64	13,800	52.07	13.29	1.6	125
617H36	(C522H0 x C536) x C17	13,390	50.67	13.26	8.7	132
617H11	(C563H0 x C551) x C17	13,280	50.95	13.06	6.1	128
E536H31	(C562H0 x C718) x C36	14,030	52.67	13.34	1.0	128
Mean[2/]		13,130	48.61	13.55	4.9	130
LSD (.05)		821	3.30	0.51	4.9	8.1
Coefficient of Variation (%)		6.3	6.9	3.8	101.3	6.3
F value		16.2**	14.1**	2.5**	6.6**	3.7**

1/ % roots with Erwinia soft rot at harvest. Weighed but not included in sugar sample.
2/ Virus treatment means were significantly different (.01) for sugar yield, beet yield, and % sucrose. Variety x virus interactions were significantly different for sugar yield (.01) and beet yield (.05).

TEST 1277. (BWYV INOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MALES, FEMALES, AND THEIR HYBRIDS: PREDICTION OF REACTION TO YELLOWS, SALINAS, CALIFORNIA, 1977

Split-plot with 8 replications
2-virus treatments
1-row plots, 30 ft. long

Planted: February 10, 1977
Inoculated with BWYV: April 28, 1977
Harvested: September 21-22, 1977

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss3/	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Yellows Scores4/ 6/10	Yellows Scores4/ 6/19	Yellows Scores4/ 7/10	Root Rot1/	Beets/ 100'
		Pounds	%	Tons	%	%	%				%	Number
Males												
417	Inc. 713A(C17)	9,660	12.1	37.87	7.5	12.78	5.0	1.5	1.5	1.3	24.7	133
Y601	Inc. Y401A(C01)	11,520	8.9	42.58	5.3	13.56	3.5	2.4	2.8	2.9	4.3	119
464	Inc. F66-64(C64)	9,060	24.0	37.20	16.4	12.21	9.1	5.1	5.4	4.9	0.3	132
Females												
F70-546H3	C562H0 x C546	9,580	14.9	38.22	5.7	12.53	9.7	4.8	5.1	5.8	0.9	137
2718H5	C564H0 x C718	8,900	16.3	36.57	8.1	12.21	8.4	4.8	5.5	5.6	6.6	134
3718H54	C706H0 x C718	11,000	12.6	42.49	8.7	12.99	4.0	3.0	4.0	4.1	6.6	135
Hybrids												
617H8	546H3 x C17	11,430	13.4	43.82	11.5	13.06	1.9	2.9	3.3	3.0	5.5	132
Y601H8	" x C01	11,870	16.7	45.26	10.3	13.14	6.8	3.4	3.5	4.0	2.8	136
464H8	" x C64	10,650	22.8	41.72	16.1	12.77	8.0	4.9	4.8	5.4	0.6	141
317H80	718H5 x C17	12,400	12.7	49.36	7.2	12.60	5.9	2.5	3.1	2.8	10.0	135
Y301H80	" x C01	12,510	14.7	49.23	8.9	12.74	6.2	3.4	4.1	3.9	7.5	132
364H80	" x C64	10,630	20.4	42.07	14.5	12.62	6.5	5.6	5.4	5.5	2.2	130
417H82	718H54 x C17	11,370	14.2	45.41	6.5	12.54	8.1	2.5	3.3	2.6	11.8	134
Y301H82	" x C01	12,330	14.4	49.04	7.1	12.60	7.7	3.1	3.6	3.0	3.5	131
364H82	" x C64	11,050	19.8	42.96	17.3	12.89	2.9	4.0	4.8	4.1	0.6	134
617H36	(C522H0 x C536) x C17	11,630	13.0	46.15	8.8	12.63	4.5	2.8	3.5	2.6	6.5	137
617H11	(C563H0 x C551) x C17	11,400	14.1	47.20	7.0	12.07	7.3	3.0	3.5	2.9	6.7	139
E536H31	(C562H0 x C718) x C36	11,370	18.9	45.10	14.3	12.61	5.4	3.3	3.4	2.9	0.4	130
Mean2/		11,020	15.8	43.46	10.1	12.70	6.2	3.5	3.9	3.7	5.6	133
LSD (.05)		743	7.4	3.00	NS	0.56	NS	0.8	0.6	0.8	5.4	9.3
Coefficient of Variation (%)		6.8	47.4	7.0	86.4	4.4	80.4	23.8	16.3	21.6	97.6	7.0
F value		17.0**	2.3**	14.5**	NS	3.2**	NS	14.6**	22.3**	20.4**	9.1**	1.9*

3/ LSD (.05) for differences within varieties for different virus treatments were 836 lbs sugar/A, 3.39 tons beets/A, and 0.57% sucrose. These differences represent approximately 6.4, 7.0, and 4.2% losses, respectively.

4/ Plots were scored for severity of yellows symptoms on a scale of 0 to 9 with 0 = no symptoms. Simple correlations between yellows scores and sugar yield % loss were 0.73, 0.69, and 0.61 for dates 6/10, 6/19, and 7/10, respectively.

TEST 1377. (NONINOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF CO, C1, AND C2 POPULATIONS OF 791
SALINAS, CALIFORNIA, 1977

Split-plot with 8 replications
2-virus treatments
1-row plots, 30 ft. long

Planted: February 10, 1977
Noninoculated
Harvested: September 22-23, 1977

Variety	Cycle1/	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot2/	Beets/ 100'
			Pounds	Tons	Percent	Percent	Number
6791	(8) C2 Syn 1	4791, 4791Daa x A	11,760	43.57	13.56	3.8	130
4791	(3) C1 Syn 1	2791-HGSaa x A	11,760	44.43	13.31	2.0	130
5791B	(4) C1 Syn 2	4791Baa x A	11,750	42.52	13.88	1.0	127
4791D	(6) C1 Syn 1	2791-HSaa x A	11,680	42.87	13.68	2.6	132
2791	(1) C0 Syn 1	1792,3,7,8aa x A	11,270	42.42	13.34	2.1	131
3791	(2) C0 Syn 2	2791aa x A	11,590	43.28	13.44	3.8	130
4791C	(5) C1 Syn 1	2791-LGSaa x A	11,520	43.41	13.33	6.1	126
4791E	(7) C1 Syn 1	2791-LSaa x A	11,480	42.93	13.41	3.1	123
Mean3/			11,600	43.18	13.49	3.1	129
LSD (.05)			NS	NS	NS	2.9	NS
Coefficient of Variation (%)			5.4	4.6	3.5	94.0	7.4
F value			NS	NS	NS	2.3*	NS

1/ C1 and C2 populations were synthesized from remnant half-sib (HS) seed. (1) and (2) = unselected, self-fertile source population that segregates Aa:aa. The following populations were evaluated and selected on the basis of their performance under BYV-BWYV infected conditions: (3) = 1 cycle of HS selection for high sugar yield; (4) = mass selection for sugar yield; (5) = HS selection for low sugar yield; (6) = HS selection for high % sucrose; (7) = HS selection for low % sucrose; and (8) = 2 cycles of HS selection for high sugar yield.

2/ % roots with Erwinia soft rot at harvest. Weighed but not included in sugar sample.

TEST 1377. (BWYV INOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF CO, C1, AND C2 POPULATIONS OF 791
SALINAS, CALIFORNIA, 1977

Split-plot with 8 replications
2-virus treatments
1-row plots, 30 ft. long

Planted: February 10, 1977
Inoculated with BWYV: April 28, 1977
Harvested: September 26-27, 1977

Variety	Cycle[1/]	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Yellows Scores[4/] 6/10	Yellows Scores[4/] 7/10	Root Rot[2/]	Beets/ 100'
		Pounds	%	Tons	%	%	%			%	Number
6791	(8) C2 Syn 1	10,200	13.0	39.69	8.0	12.84	5.2	2.5	3.6	5.0	123
4791	(3) C1 Syn 1	9,820	16.3	38.51	12.9	12.78	3.9	2.8	4.8	4.3	127
5791B	(4) C1 Syn 2	9,650	17.7	37.30	11.6	12.94	6.7	2.3	4.3	0.6	137
4791D	(6) C1 Syn 1	9,420	19.3	37.68	11.8	12.50	8.3	2.9	4.6	1.0	129
2791	(1) CO Syn 1	9,400	16.2	38.13	9.4	12.34	7.3	3.3	4.9	6.4	132
3791	(2) CO Syn 2	9,310	19.6	37.81	12.4	12.33	8.2	3.0	4.4	4.6	134
4791C	(5) C1 Syn 1	9,290	19.4	37.74	12.7	12.29	7.7	3.4	4.5	5.0	133
4791E	(7) C1 Syn 1	8,980	21.4	37.24	12.6	12.06	9.9	3.3	5.0	2.3	128
Mean[3/]		9,510	17.9	38.01	11.4	12.51	7.2	2.9	4.5	3.7	130
LSD (.05)		512	NS	NS	NS	0.37	NS	0.6	0.8	3.1	NS
C. V. (%)		5.4	36.2	5.2	60.7	3.0	52.2	18.9	17.8	84.5	7.7
F value		4.3**	NS	NS	NS	5.6**	NS	4.1**	2.3*	3.7**	NS

3/ Virus treatment means were significantly different (.01) for sugar yield, beet yield, and % sucrose. Variety x virus interactions were not significant.

4/ Plots were scored for severity of yellows symptoms on a scale of 0 to 9 with 0 = no symptoms. Simple correlations between yellows scores and sugar yield % loss were 0.53 and 0.61% for dates 6/10 and 7/10, respectively.

TEST 1477. (NONINOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MONOGERM, SELF-FERTILE, RANDOM-MATING POPULATIONS, SALINAS, CALIFORNIA, 1977

Split-plot with 8 replications
2-virus treatments
1-row plots, 30 ft. long

Planted: February 10, 1977
Noninoculated check
Harvested: September 28-29, 1977

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot1/	Beets/ 100'
		Pounds	Tons	Percent	Percent	Number
6755	5755B, 5755aa x A	13,620	49.71	13.71	5.3	139
6789	ERS 4789aa x A	12,720	44.43	14.34	1.3	133
6791	4791D, 4791aa x A	12,610	46.11	13.69	5.8	124
5740	4740aa x A	12,510	44.01	14.24	4.0	138
F69-546H4	C563HO x C546 (9056)	12,310	45.19	13.67	1.3	139
6744	5744aa x A (C789)	11,950	41.69	14.43	5.4	139
5741	4741aa x A	11,820	41.50	14.28	8.6	138
6796-2	5796-2aa x A	11,820	42.90	13.81	1.5	139
468	Inc. 868 (US 75)	11,760	43.85	13.42	3.8	128
6790	ERS 4790aa x A	11,720	40.99	14.36	1.8	135
6745	5745aa x A	11,710	43.57	13.49	5.1	137
6796-1	5796-1aa x A	11,650	42.68	13.66	8.4	139
6742	5742aa x A	11,590	42.17	13.81	1.8	143
417	Inc. 713A (C17)	10,850	40.74	13.36	26.6	130
Mean2/		12,040	43.54	13.88	5.8	136
LSD (.05)		798	2.92	.43	5.6	10.9
Coefficient of Variation (%)		6.7	6.7	3.1	97.8	8.1
F value		5.5**	5.2**	6.1**	10.7**	1.9*

1/ % roots with Erwinia soft rot at harvest. Weighed but not included in sugar sample.

2/ Virus treatment means and variety x virus treatment interactions were significantly different at the 1% level for sugar yield, beet yield, and % sucrose but were NS different for root rot.

TEST 1477. (BWYV INOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MONOGERM, SELF-FERTILE, RANDOM-MATING POPULATIONS, SALINAS, CALIFORNIA, 1977

Split-plot with 8 replications
2-virus treatments
1-row plots, 30 ft. long

Planted: February 10, 1977
Inoculated with BWYV: April 28, 1977
Harvested: September 28-29, 1977

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss3/	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Yellows Scores4/ 6/10	Yellows Scores4/ 7/10	Root Rot1/	Beets/ 100'
		Pounds	%	Tons	%	%	%			%	Number
6755	5755B, 5755aa x A	11,340	16.6	43.85	11.3	12.93	5.7	3.4	4.3	7.5	136
6789	ERS 4789aa x A	11,020	13.1	41.63	6.0	13.25	7.6	3.0	4.0	1.3	137
6791	4791D, 4791aa x A	10,910	13.3	41.72	9.4	13.10	4.3	2.5	3.5	5.0	129
5740	4740aa x A	9,870	20.8	38.03	13.3	13.01	8.7	4.3	5.1	5.3	137
F69-546H4	C563H0 x C546 (9056)	9,720	20.7	37.87	15.6	12.85	6.0	4.6	5.1	2.8	138
6744	5744aa x A (C789)	10,090	14.7	38.51	5.7	13.11	9.0	4.0	4.4	3.6	138
5741	4741aa x A	9,320	21.2	35.13	15.4	13.32	6.7	4.5	5.5	6.4	142
6796-2	5796-2aa x A	10,000	15.1	38.73	9.2	12.93	6.3	3.5	4.1	3.7	138
468	Inc. 868 (US 75)	9,280	20.6	37.74	13.4	12.29	8.5	5.5	6.4	1.6	134
6790	ERS 4790aa x A	9,530	17.7	36.76	8.8	12.93	10.1	3.6	4.6	2.3	134
6745	5745aa x A	9,480	18.2	37.17	13.7	12.76	5.5	4.5	5.1	8.1	133
6796-1	5796-1aa x A	9,880	14.9	38.76	8.9	12.75	6.6	2.9	3.6	10.2	142
6742	5742aa x A	8,920	22.8	35.64	15.1	12.54	9.0	4.9	6.5	3.3	139
417	Inc. 713A (C17)	10,830	0.0	41.28	-1.6	13.14	1.7	1.3	1.3	27.3	136
Mean2/		10,010	16.4	38.77	10.3	12.92	6.8	3.7	4.5	6.3	137
LSD (.05)		683	7.9	2.57	8.6	0.41	3.8	0.8	0.7	5.3	NS
Coefficient of Variation (%)		6.9	48.4	6.7	83.8	3.2	56.3	20.2	15.7	85.1	8.1
F value		9.3**	4.1**	7.5**	2.4**	3.6**	2.7**	17.1**	27.2**	12.0**	NS

3/ LSD (.05) for differences within varieties for different virus treatments were 900 lbs sugar/A, 3.16 tons/A, and 0.44% sucrose. These differences represent approximately 7.5, 7.3, and 3.2% losses, respectively.

4/ Plots were scored for severity of yellows symptoms on a scale of 0 to 9 with 0 = no symptoms. Simple correlations between yellows scores and sugar yield % loss were 0.90 and 0.94 for dates 6/10 and 7/10, respectively.

TEST 1577. (NONINOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MULTIGERM BREEDING LINES
SALINAS, CALIFORNIA, 1977

Split-plot with 8 replications
2-virus treatments
1-row plots, 30 ft. long

Planted: February 10, 1977
Noninoculated check
Harvested: September 26-27, 1977

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot1/	Bolting	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Number
Y631E	ERS Y231(C31)	14,540	51.46	14.13	4.0	0.1	137
Y601	Inc. Y401A(C01)	14,150	51.02	13.85	4.6	1.1	131
Y644	Inc. 4247	13,610	53.37	12.75	2.8	1.1	132
Y639	ERS Y439	13,330	48.63	13.71	1.5	0.2	137
464	Inc. F66-64	13,310	49.58	13.42	1.4	0.0	147
Y646	ERS 4219	13,310	49.52	13.45	1.0	0.0	139
Y526	Inc. Y426	13,290	46.31	14.35	1.9	1.5	130
Y640	ERS Y440	13,100	48.02	13.64	2.0	0.0	139
Y523	Inc. Y423	12,950	46.59	13.90	1.2	0.5	135
Vytomo	Hilleshög	12,920	45.67	14.13	5.5	0.0	141
Y003	Inc. Y803(C234)	12,870	46.18	13.94	0.9	0.0	134
Y630	Inc. Y430	12,540	45.13	13.91	4.5	0.0	134
468	Inc. 868(US 75)	12,250	46.05	13.30	2.1	0.6	141
F70-13	Inc. F66-13(0268)	11,650	45.54	12.79	11.4	0.0	140
417	Inc. 713A(C17)	11,640	43.50	13.39	26.2	0.0	136
E536	Inc. E402,...(C36)	11,590	42.36	13.67	0.7	0.0	132
E506	Inc. E406,...	11,540	42.58	13.54	0.3	0.2	132
Y643	Inc. 5202	10,950	44.81	12.22	9.6	12.1	136
Y645	Inc. 3204	10,710	39.88	13.43	0.3	8.3	139
604-15	Inc. 404-15CTRS	9,020	36.34	12.43	1.7	0.0	131
Mean2/		12,460	46.13	13.50	4.2	1.3	136
LSD (.05)		1,033	3.68	0.41	4.1	1.4	NS
Coefficient of Variation (%)		8.4	8.1	3.1	98.3	162.5	9.4
F value		12.6**	9.4**	14.9**	16.9**	36.5**	NS

1/ % roots with Erwinia soft rot at harvest. Weighed but not included in sugar sample.
2/ Virus treatment means and variety x virus treatment interactions were significantly different at the 1% level for sugar yield, beet yield, and % sucrose but were NS different for bolting and root rot.

TEST 1577. (BWYV INOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MULTIGERM BREEDING LINES
SALINAS, CALIFORNIA, 1977

Split-plot with 8 replications
2-virus treatments
1-row plots, 30 ft. long

Planted: February 10, 1977
Inoculated with BWYV: April 28, 1977
Harvested: September 26-27, 1977

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss3/	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Yellows Scores4/ 6/10	Yellows Scores4/ 6/19	Yellows Scores4/ 7/10	Root Rot1/	Beets/ 100'
		Pounds	%	Tons	%	%	%				%	Number
Y631E	ERS Y231(C31)	12,680	12.6	47.74	7.2	13.27	5.9	2.8	3.3	2.8	3.3	137
Y601	Inc. Y401A(C01)	12,120	13.7	45.35	10.5	13.36	3.4	2.6	3.4	3.3	6.6	124
Y644	Inc. 4247	12,200	9.7	48.63	8.3	12.53	1.7	2.3	2.9	2.4	2.6	137
Y639	ERS Y439	11,890	10.5	45.83	5.4	12.98	5.4	4.3	4.0	3.3	1.2	137
464	Inc. F66-64	9,840	25.4	39.69	19.4	12.41	7.4	5.4	4.9	4.9	0.6	145
Y646	ERS 4219	11,480	13.3	44.68	9.1	12.84	4.5	3.4	3.5	2.8	3.3	134
Y526	Inc. Y426	10,260	22.4	38.32	16.8	13.39	6.6	3.9	4.4	4.3	2.4	138
Y640	ERS Y440	10,980	16.0	43.31	9.6	12.68	7.0	4.1	3.8	3.8	0.6	144
Y523	Inc. Y423	8,800	31.9	35.77	23.1	12.29	11.6	5.6	5.4	5.0	0.9	140
Vytomo	Hilleshög	10,660	16.9	40.55	10.7	13.14	6.9	5.8	5.5	7.1	8.4	147
Y003	Inc. Y803(C234)	12,220	4.7	45.16	1.8	13.53	2.9	2.4	2.8	3.1	1.3	130
Y630	Inc. Y430	10,580	15.4	41.85	6.9	12.64	9.1	5.9	5.6	5.4	4.4	137
468	Inc. 868(US 75)	9,140	24.8	37.87	17.3	12.07	9.2	6.5	5.9	6.8	4.7	133
F70-13	Inc. F66-13(0268)	10,770	6.8	43.12	4.4	12.48	2.4	2.9	2.6	1.8	13.4	145
417	Inc. 713A(C17)	10,840	6.4	41.53	3.9	13.07	2.5	1.4	1.5	1.5	21.9	128
E536	Inc. E402,....(C36)	10,260	10.6	40.61	3.3	12.62	7.6	2.0	2.1	1.9	0.0	126
E506	Inc. E406,...	10,110	12.3	40.04	6.0	12.61	6.8	2.1	2.4	2.3	0.6	135
Y643	Inc. 5202	10,410	4.5	43.06	3.2	12.08	1.2	2.0	2.4	2.0	13.3	137
Y645	Inc. 3204	9,490	11.2	37.62	5.4	12.62	6.0	3.5	3.9	2.9	1.0	137
604-15	Inc. 404-15CTRS	7,230	19.4	32.53	9.9	11.11	10.6	6.6	6.9	6.3	2.0	131
Mean2/		10,600	14.4	41.66	9.1	12.69	5.9	3.8	3.8	3.7	4.6	136
LSD (.05)		753	8.7	2.63	8.6	C.42	4.0	0.7	0.7	0.7	3.7	12.0
Coefficient of Variation (%)		7.2	60.8	6.4	95.4	3.4	68.9	18.8	17.6	20.1	80.6	8.9
F value		24.4**	5.6**	18.7**	3.6**	13.9**	4.2**	44.2**	36.8**	43.6**	18.5**	2.2**

3/ LSD (.05) for differences within varieties for different virus treatments were 896 lbs sugar/A, 3.21 tons/A, and 0.42% sucrose. These differences represent approximately 7.2, 7.0, and 3.1% losses, respectively.
4/ Plots were scored for severity of yellows symptoms on a scale of 0 to 9 with 0 = no symptoms. Simple correlations between yellows scores and sugar yield % loss were 0.76, 0.76, and 0.78 for dates 6/10, 6/19, and 7/10, respectively.

TEST 1877-1. (NONINOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF C17 X SP6822-0 GENERATIONS
SALINAS, CALIFORNIA, 1977

Split-block with 6 replications
2-virus treatments
2-row plots, 25 ft. long

Planted: March 21, 1977
Noninoculated check
Harvested: October 6-7, 1977

Variety	Generation1/	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot2/	Beets/ 100'
			Pounds	Tons	Percent	Percent	Number
417	P_1	Inc. C17	9,550	32.43	14.72	19.0	126
6207	B_1	F_1 x C17	10,060	34.37	14.67	13.3	130
6206	F_1	417 x SP6822-0	10,700	36.06	14.83	13.8	120
Y238	F_2	Inc. F_1	10,140	34.52	14.68	9.0	129
Y338	F_3	Inc. F_2	10,460	34.62	15.09	9.5	129
6208	B_2	F_1 x SP6822-0	10,250	33.94	15.10	4.8	118
SP6822-0	P_2	Lot 0147	9,870	32.53	15.17	1.9	139
Mean3/			10,150	34.07	14.89	10.2	127
LSD (.05)			NS	3.18	NS	4.4	8.6
Coefficient of Variation (%)			6.8	5.9	3.4	36.6	5.7
F value			NS	2.4*	NS	14.3**	5.4**

1/ F_1, B_1, and B_2 were obtained from composited seed of paired crosses. F_2 and F_3 were from open-pollinated F_1 and F_2 plants, respectively.

2/ % roots with Erwinia soft rot at harvest. Weighed but not included in sugar sample.

3/ Virus treatment means were significantly different (.01) for sugar yield, beet yield, and % sucrose. Variety x virus interactions were significant for sugar yield (.01), beet yield (.01), and % sucrose (.05).

TEST 1877-1. (BWYV INOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF C17 X SP6822-0 GENERATIONS
SALINAS, CALIFORNIA, 1977

Split-block with 6 replications
2-virus treatments
2-row plots, 25 ft. long

Planted: March 21, 1977
Inoculated with BWYV: May 16, 1977
Harvested: October 6-7, 1977

Variety	Generation1/	Description	Sugar Yield Inoc.	Sugar Yield Loss4/	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Yellows Scores5/ 6/19	Yellows Scores5/ 7/6	Yellows Scores5/ 8/3	Root Rot2/	Beets/ 100'
			Pounds	%	Tons	%	%	%				%	Number
417	P_1	Inc. C17	8,710	8.8	30.90	4.5	14.10	4.0	0.0	0.8	1.3	17.4	126
6207	B_1	F_1 x C17	8,590	14.6	31.45	8.5	13.72	6.4	1.0	1.8	2.8	9.9	132
6206	F_1	417 x SP6822-0	8,150	23.8	29.58	18.0	13.78	7.0	2.2	3.8	4.3	10.9	121
Y238	F_2	Inc. F_1	7,320	27.5	26.59	22.8	13.77	6.2	3.0	4.3	5.0	11.8	122
Y338	F_3	Inc. F_2	7,550	27.5	27.54	20.3	13.70	9.1	2.7	4.2	4.5	9.3	127
6208	B_2	F_1 x SP6822-0	7,430	27.4	27.18	19.8	13.67	9.5	2.8	5.0	5.3	5.2	123
SP6822-0	P_2	Lot 0147	5,920	40.0	22.10	32.0	13.39	11.7	4.5	7.0	7.5	1.7	140
Mean3/			7,670	24.2	27.90	18.0	13.73	7.7	2.3	3.9	4.4	9.5	127
LSD (.05)			541	6.2	2.03	5.2	NS	4.7	0.5	0.8	1.1	5.5	NS
Coefficient of Variation (%)			6.0	21.8	6.2	24.3	3.6	51.9	18.6	17.8	21.6	49.4	9.7
F value			25.7**	22.6**	20.4**	26.2**	NS	2.4*	69.2**	52.7**	25.1**	6.8**	NS

4/ LSD (.05) for differences within varieties for different virus treatments were 531 lbs sugar/A, 1.40 tons beets/A, and 0.51% sucrose. These differences represent approximately 5.2, 4.1, and 3.4% losses, respectively.

5/ Plots were scored for severity of yellows symptoms on a scale of 0 to 9 with 0 = no symptoms. Simple correlations between yellows scores and sugar yield % loss were 0.99, 0.99, and 0.99 for dates 6/19, 7/6, and 8/3, respectively.

TEST 1877-2. (NONINOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF C17 X NB1 AND NB2 GENERATIONS
SALINAS, CALIFORNIA, 1977

Split-plot with 6 replications
2-virus treatments
2-row plots, 25 ft. long

Planted: March 21, 1977
Noninoculated check
Harvested: October 6-7, 1977

Variety	Generation 1/	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot 2/	Beets/ 100'
			Pounds	Tons	Percent	Percent	Number
417	P_1	Inc. C17	9,400	35.54	13.19	26.4	126
1502	P_2	Inc. NB1	8,440	31.35	13.47	1.6	122
3511	P_3	Inc. NB2	10,010	33.93	14.73	0.6	120
4277C1	S_1	S_1(C17 X NB1)	9,740	35.95	13.51	19.1	120
5277C1	S_2	S_2(C17 X NB1)	8,880	33.10	13.41	21.4	122
4278C1	S_1	S_1(C17 X NB2)	10,160	36.19	14.04	2.5	108
5278C1	S_2	S_2(C17 X NB2)	8,640	32.62	13.23	0.9	117
Mean 3/			9,320	34.10	13.65	10.4	119
LSD (.05)			887	2.53	0.55	5.4	NS
Coefficient of Variation (%)			8.1	6.3	3.4	44.1	8.0
F value			4.9**	4.5**	8.3**	37.3**	NS

1/ S_1's and S_2's were obtained from composited seed from selfed S_0 and S_1 plants, respectively.

2/ % roots with Erwinia soft rot at harvest. Weighed but not included in sugar harvest.

3/ Virus treatment means were significantly different (.01) for sugar yield, beet yield, and % sucrose. Variety x virus interactions were significant for sugar yield (.01), beet yield (.01), and % sucrose (.05).

TEST 1877-2. (BWYV INOCULATED) VIRUS YELLOWS AND PERFORMANCE EVALUATION OF C17 X NB1 AND NB2 GENERATIONS
SALINAS, CALIFORNIA, 1977

Split-plot with 6 replications
2-virus treatments
2-row plots, 25 ft. long

Planted: March 21, 1977
Inoculated with BWYV: May 26, 1977
Harvested: October 6-7, 1977

Variety	Generation1/	Sugar Yield Inoc.	Sugar Yield Loss4/	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Yellows Scores5/ 7/6	Yellows Scores5/ 8/3	Root Rot2/	Beets/ 100'
		Pounds	%	Tons	%	%	%			%	Number
417	P_1	9,050	3.4	35.33	0.4	12.78	3.1	1.0	1.0	30.2	121
1502	P_2	6,390	24.2	26.04	16.7	12.26	9.0	2.8	4.8	3.7	127
3511	P_3	7,720	22.7	28.50	16.0	13.53	8.0	2.0	3.0	0.5	116
4277C1	S_1	8,010	17.3	31.45	12.2	12.72	5.8	1.2	2.8	18.9	121
5277C1	S_2	7,440	16.1	28.82	12.9	12.88	3.8	1.5	3.0	18.2	131
4278C1	S_1	8,200	19.4	30.88	14.6	13.28	5.4	1.5	2.3	6.2	106
5278C1	S_2	7,070	18.3	27.73	15.0	12.72	3.9	1.2	2.5	3.6	130
Mean3/		7,700	17.3	29.82	12.5	12.88	5.6	1.6	2.8	11.6	122
LSD (.05)		570	6.8	1.69	5.8	0.55	3.7	0.5	0.7	5.5	13.5
Coefficient of Variation(%)		6.3	33.5	4.8	39.1	3.6	56.0	26.5	19.8	40.4	9.4
F value		18.7**	8.2**	27.1**	7.8**	4.7**	3.0*	13.6**	25.5**	32.7**	3.6**

4/ LSD (.05) for differences within varieties for different virus treatments were 507 lbs. sugar/A, 1.53 tons beets/A, and 0.36% sucrose. These differences represent approximately 5.4, 4.5, and 2.7% losses, respectively.

5/ Plots were scored for severity of yellows symptoms on a scale of 0 to 9 with 0=no symptoms. Simple correlations between yellows scores and sugar yield % loss were 0.72 and 0.83 for dates 7/6 and 8/3, respectively.

TEST 1777. PRELIMINARY EVALUATION OF LOSSES CAUSED BY BEET RUST (UROMYCES BETAE), SALINAS, CALIFORNIA, 1977

Split-plot with 8 replications
2-rust treatments
2-row plots, 81 ft. long

Planted: March 22, 1977
Sprayed: August 3 and 18, 1977
Harvested: October 12, 1977

	Sugar Yield/A			Beet Yield/A			Sucrose			Root	Beets/
Variety	Control1/	No Control	Loss	Control	No Control	Loss	Control	No Control	Loss	Rot3/	100'
	Pounds	Pounds	%	Tons	Tons	%	%	%	%	%	Number
US H10B	12,170	11,810	2.7	39.38	38.46	2.2	15.48	15.37	0.6	6.0	119
Mono-Hy D2	13,020	12,090	7.0	40.75	38.24	6.2	15.99	15.83	0.9	5.1	119
Mean2/	12,590	11,950	4.9	40.06	38.35	4.2	15.73	15.60	0.7	5.5	119
LSD (.05)	351	NS	NS	0.94	NS	NS	0.23	0.41	NS	NS	NS
C. V. (%)	2.4	4.0	103.0	2.0	3.3	106.7	1.3	2.2	316.7	29.3	3.5
F value	32.6**	NS	NS	11.9*	NS	NS	27.1**	7.0*	NS	NS	NS

1/ Rust was allowed to develop by natural infection. Following its appearance, control plots were sprayed with Plantvax at 2 lbs. ai/A and at 4 lbs. ai/A on 8/3 and 8/18, respectively. Rust was allowed to develop too severely prior to fungicide application and control was minimal until very late in the season. By 9/15/77 differences in rust severity on Mono-Hy D2 were becoming obvious. In future tests, fungicide application should begin before rust is evident. Plantvax had no obvious effect on powdery mildew or other diseases.

2/ Rust treatment means were significantly different for sugar yield and root yield at the 5% level. A variety x rust interaction was significant for root yield at the 5% level.

3/ % roots with Erwinia soft rot at harvest. Diseased roots were weighed but not included in sugar sample.

TEST 1177B. PERFORMANCE EVALUATION OF CO, C1, AND C2 POPULATIONS OF 791, SALINAS, CALIFORNIA, 1977

RCB with 8 replications1/
2-row plots, 30 ft. long

Planted: February 9, 1977
Harvested: October 3-4, 1977

Variety	Cycle2/	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Amino N PPM	Na PPM	K PPM	Impur. Index	Recov. Sugar/A Pounds	Recov. Sugar Percent
6791	(8) C2 Syn 1	12,910	46.05	14.07	1860	360	2220	1790	9,470	73.2
5791B	(4) C1 Syn 2	12,350	42.87	14.42	1920	320	2340	1840	9,000	72.5
4791D	(6) C1 Syn 1	12,330	44.40	13.88	1890	370	2270	1890	8,900	71.6
3791	(2) CO Syn 2	12,240	44.11	13.91	1520	370	2100	1570	9,380	76.5
4791	(3) C1 Syn 1	12,200	43.22	14.14	1390	300	2040	1440	9,590	78.5
2791	(1) CO Syn 1	12,060	41.93	14.45	2210	370	2210	2000	8,480	70.0
4791C	(5) C1 Syn 1	11,910	43.89	13.59	1800	460	2150	1850	8,650	72.3
4791E	(7) C1 Syn 1	11,670	42.73	13.68	1970	470	2160	1960	8,280	70.6
Mean		12,210	43.65	14.02	1820	380	2190	1790	8,970	73.1
LSD (.05)		564	1.98	NS	NS	90	NS	NS	NS	NS
Coefficient of Variation(%)		4.6	4.5	4.9	49.0	23.9	8.6	37.7	15.2	13.9
F value		3.4**	3.3**	NS	NS	3.4**	NS	NS	NS	NS

1/ Extracted from a test with 20 entries.

2/ C1 and C2 populations were synthesized from remnant half-sib (HS) seed. (1) and (2) = unselected, self-fertile source population that segregates Aa:aa. The following populations were evaluated and selected on the basis of their performance under BYV-BWYV infected conditions: (3) = 1 cycle of HS selection for high sugar yield; (4) = mass selection for sugar yield; (5) = HS selection for low sugar yield; (6) HS selection for high % sucrose; (7) = HS selection for low % sucrose; and (8) = 2 cycles of HS selection for high sugar yield.

TEST 1177A. COMPARISON OF S_1, FULL-SIB, AND TEST-CROSS EVALUATION: 791 PER SE, SALINAS, CALIFORNIA, 1977

RCB with 8 replications1/
2-row plots, 30 ft. long

Planted: February 9, 1977
Harvested: October 3-4, 1977

Variety	Cycle2/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Amino N	Na	K	Impur. Index3/	Recov. Sugar/A4/	Recov. Sugar
		Pounds	Tons	Percent	PPM	PPM	PPM		Pounds	Percent
US H10B		13,440	47.13	14.33	1170	380	2090	1270	10,910	81.0
6791	C2 Syn 1 GS by HS eval.	12,910	46.05	14.07	1860	360	2220	1790	9,470	73.2
5791I	C1 Syn 1 % S by S_1 eval.	12,600	44.28	14.23	1730	370	2100	1690	9,460	74.7
5791F	C1 Syn 1 GS by S_1 eval.	12,460	45.84	13.60	1400	490	2480	1610	9,520	75.9
5791N	C1 Syn 1 K by S_1 eval.	12,450	43.08	14.48	1870	260	1830	1680	9,330	74.8
5791B	C1 Syn 2 GS by mass sel.	12,350	42.87	14.42	1920	320	2340	1840	9,000	72.5
5791H	C1 Syn 1 GS by FS eval.	12,280	46.80	13.18	1730	520	2250	1870	8,840	72.0
3791	C0 Syn 2 unselected source	12,240	44.11	13.91	1520	370	2100	1570	9,380	76.5
5791K	C1 Syn 1 % S by FS eval.	12,170	42.65	14.29	1580	290	2090	1570	9,350	76.5
5791J	C1 Syn 1 % S by TC eval.	12,110	42.37	14.31	1500	330	1940	1480	9,430	77.8
5791G	C1 Syn 1 GS by TC eval.	12,100	43.41	13.96	1740	290	2260	1710	9,030	74.4
2791	C0 Syn 1 unselected source	12,060	41.93	14.45	2210	370	2210	2000	8,480	70.0
5791M	C1 Syn 1 Na by S_1 eval.	11,840	42.76	13.85	2360	290	2110	2200	8,030	67.1
5791O	C1 Syn 1 Imp.I. by S_1 eval.	11,640	42.95	13.59	1410	440	2010	1510	9,040	77.3
5791L	C1 Syn 1 NH_2-N by S_1 eval.	11,480	42.61	13.46	1270	510	2200	1510	8,930	77.4
Mean		12,280	43.92	14.01	1686	373	2148	1685	9,213	74.7
LSD (.05)		571	2.30	0.68	557	93	171	405	889	6.1
Coefficient of Variation (%)		4.7	5.3	4.9	33.3	25.2	8.0	24.2	9.7	8.2
F value		5.7**	4.4**	2.8**	2.8**	6.4**	6.9**	2.6**	3.9**	2.6**

1/ Extracted from a test with 20 entries.
2/ C1 Syn 1 populations were synthesized from remnant S_1 seed for S_1 and TC evaluations and from remnant FS seed for FS evaluations. For TC evaluations, 546H3 was used as the common tester. Selection intensity was approximately 10% for all traits and evaluation methods. GS and % S were selections for high performance. NH_2-N, Na, K, and Impurity index selections were made for lower values.
3/ Impurity index = (10 · ppm NH_2-N + 3.5 · ppm Na + 2.5 · ppm K)/% sucrose.
4/ Recoverable (Extractable) sugar/A = Lbs. Sugar/A - (1.5)(0.0001)(Impurity Index)(Lbs. Sugar/A).

TEST 1677. COMPARISON OF S_1, FULL-SIB, AND TEST-CROSS EVALUATION: 791 PER SE, SALINAS, CALIFORNIA, 1977

RCB with 8 replications
2-row plots, 39 ft. long

Planted: March 22, 1977
Harvested: October 4-6, 1977

Variety	Cycle1/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Amino N	Na	K	Impur. Index2/	Recov. Sugar/A3/	Recov. Sugar
		Pounds	Tons	Percent	PPM	PPM	PPM		Pounds	Percent
US H10B		12,130	40.06	15.14	610	160	2280	820	10,650	87.7
5791I	C1 Syn 1 % S by S_1 eval.	11,860	38.31	15.49	770	140	2180	890	10,290	86.7
5791N	C1 Syn 1 K by S_1 eval.	11,660	38.14	15.32	760	130	1960	850	10,180	87.2
5791F	C1 Syn 1 GS by S_1 eval.	11,640	39.84	14.63	640	190	2680	940	10,000	85.9
6791	C2 Syn 1 GS by HS eval.	11,330	37.43	15.20	770	160	2370	940	9,730	85.9
5791K	C1 Syn 1 % S by FS eval.	11,310	36.61	15.47	690	140	2180	840	9,890	87.5
5791B	C1 Syn 2 GS by mass sel.	11,190	36.20	15.51	860	150	2470	990	9,520	85.1
5791H	C1 Syn 1 GS by FS eval.	11,190	38.19	14.68	780	220	2550	1030	9,470	84.6
5791M	C1 Syn 1 Na by S_1 eval.	11,140	36.95	15.09	860	120	2240	970	9,520	85.4
3791	C0 Syn 2 unselected source	10,980	36.48	15.12	730	170	2360	920	9,460	86.1
5791J	C1 Syn 1 % S by TC eval.	10,850	35.89	15.14	750	150	2210	900	9,390	86.4
2791	C0 Syn 1 unselected source	10,840	36.13	15.02	860	150	2440	1030	9,190	84.6
5791O	C1 Syn 1 Imp.I. by S_1 eval.	10,730	36.45	14.74	670	160	2510	930	9,240	86.0
5791G	C1 Syn 1 GS by TC eval.	10,710	36.13	14.85	730	150	2470	950	9,190	85.8
5791L	C1 Syn 1 NH_2-N by S_1 eval.	10,410	36.38	14.32	640	200	2700	980	8,890	85.3
417(C17)		10,190	35.01	14.57	660	170	2610	950	8,750	85.7
Mean		11,140	37.14	15.02	740	160	2390	930	9,590	86.0
LSD (.05)		593	2.00	0.45	132	28.6	185	123	600	1.8
Coefficient of Variation (%)		5.4	5.4	3.0	18.1	18.1	7.8	13.2	6.3	2.2
F value		6.1**	4.0**	5.0**	2.9**	6.4**	9.7**	2.0*	5.8**	2.0*

1/ C1 Syn 1 populations were synthesized from remnant S_1 seed for S_1 and TC evaluations and from remnant FS seed for FS evaluations. For TC evaluations, 546H3 was used as the common tester. Selection intensity was approximately 10% for all traits and evaluation methods. GS and % S were selections for high performance. NH_2-N, Na, K, and Impurity index selections were made for lower values.
2/ Impurity Index = (10 · ppm NH_2-N + 3.5 · ppm Na + 2.5 · ppm K)/% sucrose.
3/ Recoverable (Extractable) Sugar/A = Lbs. Sugar/A - (1.5)(0.0001)(Impurity Index)(Lbs. Sugar/A).

TESTS 1977-1 AND 1977-2. COMPARISON OF S_1, FULL-SIB, AND TEST-CROSS EVALUATION: 791 PER SE AND 546H3 x 791
SALINAS, CALIFORNIA, 1977

8 x 8 Latin square1/
2-row plots, 25 ft. long

Planted: May 3, 1977
Harvested: October 26-27, 1977

Synthetic	Cycle2/	Sugar Yield/A Per Se	Sugar Yield/A 546H3 x3/	Beet Yield/A Per Se	Beet Yield/A 546H3 x	Sucrose Per Se	Sucrose 546H3 x	Beet/100' Per Se	Beet/100' 546H3 x	Root Rot4/
		Pounds	Pounds	Tons	Tons	%	%	Number	Number	%
5791F	C1 Syn 1 GS by S_1 eval.	8,420	8,140	30.15	28.91	13.98	14.09	135	136	7.4
5791H	C1 Syn 1 GS by FS eval.	8,350	8,030	29.34	28.93	14.23	13.90	129	132	9.5
6791	C2 Syn 1 GS by HS eval.	8,340	8,160	29.04	28.35	14.36	14.41	117	132	8.2
5791K	C1 Syn 1 % S by FS eval.	8,320	7,910	27.81	27.19	14.98	14.56	127	141	3.2
5791I	C1 Syn 1 % S by S_1 eval.	8,220	8,330	28.24	28.97	14.56	14.38	119	134	6.0
5791G	C1 Syn 1 GS by TC eval.	8,060	8,110	28.43	28.41	14.19	14.27	132	130	10.7
3791	C0 Syn 2 unselected source	7,890	7,990	27.75	28.03	14.22	14.26	111	129	5.9
5791J	C1 Syn 1 % S by TX eval.	7,800	7,820	26.34	27.23	14.80	14.34	126	134	3.4
Mean		8,170	8,060	28.39	28.25	14.41	14.28	124	133	6.8
LSD (.05)		360	NS	1.11	1.35	0.31	NS	9.6	NS	3.8
Coefficient of Variation (%)		4.4	4.6	3.9	4.8	2.1	3.2	7.6	5.7	55.6
F value		3.4**	NS	9.0**	2.3*	9.8**	NS	5.8**	NS	4.1**

1/ 791 per se and F70-546H3 x 791 entries evaluated in adjacent 8 x 8 tests.

2/ C1 Syn 1 populations were synthesized from remnant S_1 seed for S_1 and TC evaluations and from remnant FS seed for FS evaluations. For TC evaluations, 546H3 was used as the common tester. Selection intensity was approximately 10% for all traits and evaluation methods.

3/ At the same time that stecklings from S_1 and FS remnant seed were being increased in recombination plots to produce the C1 Syn 1, they also were crossed to F70-546H3.

4/ % roots with Erwinia soft rot at harvest in per se. Weighed but not included in sugar sample.

SUMMARY OF RELATIVE PERFORMANCE OF C1 SYN 1 POPULATIONS OF 791 PER SE FOR YIELD, 1976-77[1]

Synthetic	Cycle	Sugar Yield (lbs/A) 876-1	1177	1677	1977-1	B476	Beet Yield (tons/A) 876-1	1177	1677	1977-1	B476
3791	C0 Syn 2 unselected source	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
5791F	C1 Syn 1 GS by S_1 eval.	111.2	101.8	106.0	106.7	120.8	109.9	103.9	109.2	108.7	113.7
5791G	C1 Syn 1 GS by TC eval.	100.0	98.8	97.5	102.2	99.6	99.2	98.4	99.0	102.4	99.8
5791H	C1 Syn 1 GS by FS eval.	102.9	100.3	101.9	105.8	107.1	106.6	106.1	104.7	105.7	106.1
5791I	C1 Syn 1 % S by S_1 eval.	108.1	102.9	108.0	104.2	111.2	100.9	100.4	105.0	101.8	98.7
5791J	C1 Syn 1 % S by TC eval.	107.9	98.9	98.8	98.8	107.6	101.1	96.1	98.4	94.9	96.9
5791K	C1 Syn 1 % S by FS eval.	102.8	99.4	103.0	105.5	103.0	97.1	96.7	100.4	100.2	97.4
Mean		10,599	12,281	11,221	8,174	7,726	38.61	44.21	37.35	28.39	27.84
LSD (.05) as %		6.6	NS	4.8	4.4	6.9	3.8	5.5	5.0	3.9	6.2
Coefficient of Variation (%)		6.6	5.1	4.8	4.4	8.0	3.8	5.4	4.9	3.9	7.3
F value		3.2**	NS	4.9**	3.4**	9.0**	10.9**	3.6**	5.0**	9.0**	15.6**

Synthetic	Cycle	% Sucrose 876-1	1177	1677	1977-1	B476	Recoverable Sugar (lbs/A)[2] 876-1	1177	1677
3791	C0 Syn 2 unselected source	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
5791F	C1 Syn 1 GS by S_1 eval.	101.2	97.8	96.8	98.3	106.2	118.1	101.5	105.6
5791G	C1 Syn 1 GS by TC eval.	100.8	100.4	98.2	99.8	99.8	103.6	96.3	97.2
5791H	C1 Syn 1 GS by FS eval.	96.5	94.7	97.1	100.1	101.0	102.2	94.3	100.1
5791I	C1 Syn 1 % S by S_1 eval.	107.2	102.3	102.5	102.4	112.8	102.0	100.9	108.7
5791J	C1 Syn 1 % S by TC eval.	107.0	102.9	100.2	104.1	111.0	113.0	100.6	99.2
5791K	C1 Syn 1 % S by FS eval.	106.0	102.7	102.3	105.3	105.5	107.3	99.8	104.5
Mean		13.73	13.93	15.06	14.41	13.88	8,424	9,287	9,671
LSD (.05) as %		4.5	4.8	3.2	2.1	3.6	11.2	NS	5.6
Coefficient of Variation (%)		4.4	4.8	3.2	2.1	3.9	11.1	9.7	5.6
F value		6.5**	3.2*	4.2**	9.8**	11.3**	2.5*	NS	4.2**

1/ Data were extracted from 876-1 from 1976, tests 1177, 1677, and 1977-1 from 1977, and B476 from Imperial Val.
2/ Recov. Sugar/A = lbs. sugar/A - (1.5)(0.0001)(Impurity Index)(lbs. sugar/A).

SUMMARY OF RELATIVE PERFORMANCE OF C1 SYN 1 POPULATIONS OF 791 PER SE FOR COMPONENTS OF IMPURITY, 1976-77[1/]

Synthetic	Cycle	NH_2-N (ppm) 876-1	1177	1677	Sodium (ppm) 876-1	1177	1677	Potassium (ppm) 876-1	1177	1677
3791	C0 Syn 2 unselected source	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
5791L	C1 Syn 1 NH_2-N by S_1 eval.	60.4	83.6	87.7	118.7	138.5	115.9	99.2	104.8	114.7
5791M	C1 Syn 1 Na by S_1 eval.	139.3	155.1	117.5	66.1	78.2	67.4	94.8	100.5	95.0
5791N	C1 Syn 1 K by S_1 eval.	106.6	122.5	103.3	71.5	71.6	78.7	79.9	87.1	82.9
5791O	C1 Syn 1 Imp. I. by S_1 eval.	64.8	92.5	91.7	104.3	121.2	94.7	104.8	95.8	106.5
Mean		1173	1687	734	591	374	156	1882	2048	2354
LSD (.05) as %		40.4	34.2	18.9	20.0	26.8	19.5	7.4	7.9	7.8
Coefficient of Variation (%)		35.9	33.3	18.5	19.5	26.2	19.1	7.2	7.7	7.6
F value		6.1**	4.8**	3.1*	12.5**	9.0**	9.4**	15.2**	6.4**	19.9**

Synthetic	Cycle	Impurity Index[2/] 876-1	1177	1677	Recov. Sugar (%)[3/] 876-1	1177	1677	Recov. Sugar/Ton[4/] 876-1	1177	1677
3791	C0 Syn 2 unselected source	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
5791L	C1 Syn 1 NH_2-N by S_1 eval.	79.3	96.1	106.4	105.9	101.2	99.0	102.2	98.2	93.8
5791M	C1 Syn 1 Na by S_1 eval.	116.0	140.1	105.2	95.5	87.7	99.2	97.9	87.9	98.9
5791N	C1 Syn 1 K by S_1 eval.	91.6	107.3	91.8	102.4	97.8	101.3	106.9	102.0	102.6
5791O	C1 Syn 1 Imp. I. by S_1 eval.	81.9	96.7	100.8	105.1	101.0	99.9	101.7	98.5	97.4
Mean		1387	1693	932	79.2	74.6	86.0	212.1	207.3	257.1
LSD (.05) as %		26.0	25.1	NS	6.8	8.5	NS	--	NS	5.1
Coefficient of Variation (%)		25.4	24.5	14.8	6.7	8.3	2.4	--	10.1	5.0
F value		3.1*	3.9*	NS	3.1*	3.9*	NS	--	NS	3.5*

1/ Data were extracted from test 876-1 from 1976 and tests 1177 and 1677 from 1977.
2/ Impurity Index = (10 · ppm NH_2-N + 3.5 · ppm Na + 2.5 ppm K)/% sucrose.
3/ % Recoverable Sugar = {[lbs. sugar/A - (1.5)(0.0001)(Impurity Index)(lbs. sugar/A)]/lbs. sugar/A}100.
4/ Recoverable Sugar/Ton = (% sucrose)(0.2)(% recoverable sugar).

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1976-77

Location: ARS-USDA, Imperial Valley Conservation Research Center.

Soil type: Holtville silty clay loam.

Previous crops: Cereals or lettuce, 1976; Beets, 1974-5.

Fertilizer used: Preplant: 200 lbs/A 11:48:0 and 200 lbs/A 46:0:0 (urea) broadcast and disced in before listing.
Sidedressing: 180 lbs/A 46:0:0 (urea).

Total fertilization (lbs/A): N(197): P_2O_5(96): K_2O(0)

Summary: 1976-7 Tests, Brawley, California

Test No.	Sowing Date 1976*	No. Entries per Test	No. Reps	No. Rows per Plot**	Plot Row Length Ft.	Harvest Date 1977	Test Design
B177	9/9	20	10	2	40	5/18-20	RCB
B277	9/9	10	10	1	40	5/18-19	LS
B377	9/9	10	10	1	40	5/17-18	LS
B477	9/8	10	10	1	40	5/17-18	LS
B577	9/9	28	8	1	24	5/21	RCB
B677	9/9	128	2	1	24	Observation Test	

* Watered up starting 9/10/76. ** Rows 32" wide.

Irrigations: 4" ± rain from Kathlene 9/10/76; then sprinkler irrigation on and off for 3 weeks to establish stand. Furrow irrigation on : 10/25/76, 2/24/77, 3/14/77, 4/10/77.

Diseases and insects: Control measures as needed throughout growing season including sulfur for powdery mildew control. Virus yellows symptoms were obvious at harvest. Erwinia rot was prevalent throughout tests.

Harvest and sugar analysis: Plots were machine harvested using Holly's spike-wheel lifter. Roots from total plot were weighed and two six- to eight- beet samples removed. Sugar analyses were by Holly Sugar Corporation, Brawley, California.

Remarks: Stands were consistently good. Test reliability should be good. Virus yellows, probably BWYV, appeared to be a significant influence on yield; hybrids with known yellows resistance ranked high and those with less resistance ranked low. A very high incidence of *Erwinia* occurred as evidenced by vascular necrosis, pink areas in crown and root upon exposure to air, soft rot, etc. In tests like B177 where components resistant to *Erwinia* were involved, e.g., C546, C36, C64, etc., severity of soft rot was held in check. In tests like B277 where all entries were uniformly susceptible, a significant amount of soft rot was started. It would be a mistake to plant cultivars highly susceptible to *Erwinia* in the Imperial Valley.

We wish to acknowledge the supervision of these plots by J. Robertson and C. Brown, I. V. Cons. Res. Center, Brawley, California.

TEST B177. HYBRID TEST, BRAWLEY, CALIFORNIA, 1976-7

20 Varieties, 10 Reps
2-row plots, 40 ft. long, 32" beds

Planted: September 8-9, 1976
Harvested: May 18-20, 1977

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Clean Beets	Bolting	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Number
Y601H31	3718H3 x C01	9,639	33.81	14.26	95.5	0.6	98
Y601HL17	5796-1H2 x C01	9,477	33.24	14.26	94.8	4.4	100
5717H8	F70-546H3 x 4232	9,376	34.42	13.63	92.8	6.1	102
E637H8	F70-546H3 x E537	9,320	33.42	13.94	93.0	0.1	98
E536H8	F70-546H3 x C36	9,318	34.04	13.69	92.8	4.1	100
Y601H8	F70-546H3 x C01	9,297	32.34	14.37	95.4	1.0	99
US H10B	546H3 x C17 (LOT 3084)	9,283	33.65	13.79	92.8	1.6	100
617H29	3536-97H72 x C17	9,276	34.03	13.64	92.1	0.0	101
Y631H8	F70-546H3 x C31	9,263	32.15	14.42	94.2	0.8	97
E638H8	F70-546H3 x E538	9,259	34.46	13.43	91.9	0.6	102
Y617H31	3718H3 x Y517	9,252	34.49	13.42	93.1	0.9	98
517H12	F59-546H4 x C17	9,184	33.76	13.61	91.9	0.7	106
Y644H8	F70-546H3 x 4247	9,182	34.37	13.35	93.8	2.5	101
617H36	3536-97H22 x C17	9,105	33.86	13.44	91.1	0.5	105
E639H8	F70-546H3 x E539	9,062	33.71	13.44	93.0	1.0	101
617H11	8551H4 x C17	8,965	33.32	13.46	91.4	0.1	103
623-5H8	F70-546H3 x 523-5A	8,916	33.14	13.46	92.1	0.0	97
464H8	F70-546H3 x F66-64	8,756	31.96	13.70	94.1	0.5	99
Y643H8	F70-546H3 x 5202	8,746	33.17	13.19	93.4	1.4	101
Y630H8	F70-546H3 x Y430	8,646	31.59	13.69	93.3	1.0	100
Mean		9,166	33.45	13.71	93.1	1.4	100
LSD (.05)		409	1.20	0.41	1.2	1.3	4.4
Coefficient of Variation (%)		5.1	4.1	3.4	1.4	109.0	5.0
F value		3.0**	4.0**	6.1**	8.3**	11.8**	2.4**

TEST B277. F_1 HYBRIDS X C17 TEST, BRAWLEY, CALIFORNIA, 1976-77

10 X 10 Latin square
1-row plots, 40 ft. long, 32" beds

Planted: September 9, 1976
Harvested: May 18-19, 1977

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Clean Beets	Bolting	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Number
617H72	718H0 x C17	10,063	38.34	13.12	91.9	0.0	100
617H29	536-97H72 x C17	9,216	34.69	13.29	91.2	0.0	108
617HL8	701H72 x C17	9,022	33.84	13.34	91.6	1.0	99
617HL10	703H72 x C17	8,957	34.86	12.86	92.1	0.8	99
617HL15	788H72 x C17	8,877	33.15	13.38	90.6	1.2	99
617HL11	761-3H72 x C17	8,815	33.26	13.26	91.0	1.2	100
617HL9	702H72 x C17	8,766	33.54	13.05	92.8	0.0	95
617HL13	779H72 x C17	8,763	32.90	13.32	89.7	1.5	99
617HL14	780H72 x C17	8,650	33.96	12.75	92.0	0.5	100
617HL12	778H72 x C17	8,568	31.09	13.78	91.0	3.2	96
Mean		8,970	33.96	13.22	91.4	0.9	99
LSD (.05)		532	1.97	0.25	NS	1.1	NS
Coefficient of Variation (%)		6.7	6.5	2.1	2.4	127.6	8.8
F value		5.1**	7.1**	10.9**	NS	6.6**	NS

TEST B377. F_1 HYBRIDS X C01 TEST, BRAWLEY, CALIFORNIA, 1976-7

10 X 10 Latin square
1-row plots, 40 ft. long, 32" beds

Planted: September 9, 1976
Harvested: May 17-18, 1977

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Clean Beets	Bolting	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Number
Y601H72	718H0 x C01	9,769	35.39	13.78	93.7	0.3	94
Y601HL11	761-3H72 x C01	9,658	34.91	13.83	93.9	1.6	95
Y601HL9	702H72 x C01	9,578	34.84	13.74	93.2	0.8	99
Y601HL15	788H72 x C01	9,562	34.00	14.06	93.8	0.8	92
Y601H29	536-97H72 x C01	9,408	33.58	14.01	92.6	0.2	98
Y601HL13	779H72 x C01	9,366	33.96	13.80	92.4	0.5	100
Y601HL8	701H72 x C01	9,334	33.00	14.14	93.1	2.9	96
Y601HL14	780H72 x C01	9,318	35.19	13.25	93.9	2.6	96
Y601HL12	778H72 x C01	9,260	32.83	14.11	92.3	6.6	98
Y601HL10	703H72 x C01	8,839	33.04	13.37	93.6	0.8	97
Mean		9,409	34.07	13.81	93.3	1.7	96
LSD (.05)		NS	1.79	0.31	NS	2.0	NS
Coefficient of Variation (%)		6.8	5.9	2.6	1.6	129.8	7.1
F value		NS	2.3*	7.3**	NS	7.8**	NS

TEST B477. BROADBASE HYBRID TEST, BRAWLEY, CALIFORNIA, 1976-77

10 X 10 Latin square
1-row plots, 40 ft. long, 32" beds

Planted: September 8, 1976
Harvested: May 17-18, 1977

Variety	Description	Acre Yields Sugar	Acre Yields Beets	Sucrose	Clean Beets	Bolting	Beets/ 100'
		Pounds	Tons	Percent	Percent	Percent	Number
617HL7	5755BH2 x C17	8,934	33.34	13.40	91.0	1.6	95
Y601HL17	5796-1H2 x C01	8,894	32.47	13.73	93.9	6.0	98
US H10B	546H3 x C17 (LOT 3084)	8,883	33.64	13.23	90.5	1.0	105
617HL2	5741H0 x C17	8,762	33.32	13.14	91.0	2.9	97
Y601HL18	5796-2H2 x C01	8,509	31.06	13.70	94.0	5.8	93
Y601HL1	5740H0 x C01	8,474	31.22	13.58	93.5	2.5	96
617HL1	5740H0 x C17	8,304	31.56	13.17	90.8	1.6	97
Y601HL2	5741H0 x C01	8,269	30.17	13.70	92.9	4.3	98
617HL4	5744H0 x C17	8.145	30.67	13.29	90.7	2.2	102
617HL5	5745H0 x C17	8,003	30.13	13.30	89.6	5.0	101
Mean		8,518	31.76	13.43	91.8	3.3	98
LSD (.05)		467	1.64	0.37	1.7	2.8	5.8
Coefficient of Variation (%)		6.2	5.8	3.1	2.1	97.1	6.6
F value		4.1**	5.3**	3.2**	7.5**	3.4**	3.1**

TEST B577. OPEN-POLLINATED VARIETY TEST, BRAWLEY, CALIFORNIA, 1976-77

28 Varieties, 8 Reps
1-row plots, 24 ft. long, 32" beds

Planted: September 9, 1976
Harvested: May 21, 1977

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Clean Beets	Bolting	Beets/ 100'	Root Rot 1/
		Pounds	Tons	Percent	Percent	Percent	Number	Percent
US H10B	546H3 x C17 (LOT 3084)	9,174	35.86	12.79	92.1	1.2	89	17.9
6791H37	Y517HO x 4791,D	9,070	34.98	12.97	91.5	10.0	90	
Y601H37	Y417HO x C01	8,885	33.42	13.27	93.9	4.8	88	
Y601	INC. Y401A (C01)	8,870	31.39	14.12	96.0	5.7	81	
623-5E	ERS 417-1	8,718	32.20	13.51	91.4	0.5	99	17.2
6794H37	Y517HO x 5794	8,663	34.42	12.57	93.5	0.5	90	
Y633	ERS Y233	8,328	34.22	12.17	92.4	1.7	95	
Y631E	ERS Y231	8,314	29.59	14.07	95.1	1.2	83	
6742H37	Y517HO x 5742	8,263	33.45	12.36	93.1	6.8	79	
Y640	ERS Y440	8,248	31.91	12.94	93.6	2.4	88	
Y646	ERS 4219	8,173	31.94	12.81	95.0	0.0	92	
E638	INC. E538	8,137	32.29	1[illegible].60	91.7	4.8	90	6.3
417	INC. 713A (C17)	8,120	31.93	12.72	91.3	1.0	97	32.1
Y639	ERS Y439	8,106	31.79	12.74	92.8	15.0	80	
Y631	INC. Y331 (C31)	8,001	29.50	13.56	93.8	3.1	80	
6792H37	Y517HO x 5792	7,931	31.58	12.53	92.9	2.8	85	
E637	INC. E537	7,812	30.28	12.88	92.6	3.7	87	17.3
Y644	INC. 4247	7,760	33.17	11.69	94.5	10.0	84	
E536	INC. E402,5,6,34 (C36)	7,713	30.22	12.76	93.4	7.7	82	0.7
E639	INC. E539	7,700	31.40	12.30	92.6	11.4	87	6.6
E606	ERS E406	7,690	31.59	12.17	92.0	10.9	93	1.1
Y645H37	Y417HO x 3204	7,635	30.51	12.51	93.0	25.8	82	
Y630	INC. Y430	7,560	29.11	12.99	94.1	3.3	87	
E602	ERS E402 (C02)	7,519	31.18	12.11	91.6	2.2	88	0.0
E634	ERS E434	7,491	30.94	12.10	91.6	10.7	94	1.1
Y641	ERS Y441	7,454	29.42	12.70	96.6	8.0	84	
Y643	INC. 5202	7,434	30.62	12.14	93.8	4.8	81	15.2
Y617HO	Y517HO x Y517	6,752	26.94	12.55	90.3	9.2	94	
Mean		8,054	31.64	12.74	93.1	6.0	87	
LSD (.05)		715	2.40	0.63	2.1	7.2	10.1	
Coefficient of Variation (%)		9.0	7.7	5.1	2.3	120.3	11.7	
F value		4.9**	5.1**	6.3**	3.9**	4.8**	2.3	

1/ Counted at harvest. % of roots showing rot. Probably caused by Erwinia.

VARIETY TEST, IMPERIAL VALLEY, CALIFORNIA, 1977
By Holly Sugar Corporation (11901-1)

12 replications, 1-row plots, RCB
25 ft. long, 30-inch rows

Planted: September 23, 1976
Harvested: May 5, 1977

Variety	Description	Ext. Sugar/A	Ext. Sugar/T	Gross Sugar/A	Beets/A	Sucrose	Beets/ 100'
		Pounds	Pounds	Pounds	Tons	Percent	Number
Y644H29	(718H0 x 536) x 4247	5,876	199.5	8,323	29.4	14.14	131
Y601HL1	740H0 x C01	5,833	205.0	8,173	28.5	14.35	109
Y601H31	(562H0 x 718) x C01	5,494	210.3	7,621	26.2	14.56	112
Y631H31	(562H0 x 718) x C31	5,438	210.8	7,537	25.9	14.57	126
517H12	(563H0 x 546) x C17	5,354	202.7	7,525	26.4	14.26	120
US H10B	(562H0 x 546) x C17	5,254	203.5	7,376	25.8	14.28	139
617H11	(563H0 x 551) x C17	5,174	199.3	7,339	26.0	14.12	123
E637H31	(562H0 x 718) x E537	5,169	201.7	7,287	25.6	14.22	119
US H10B	(562H0 x 546) x C17	5,163	206.2	7,210	25.1	14.39	143
Y643H29	(718H0 x 536) x 5202	5,140	189.5	7,441	27.1	13.72	128
E536H29	(718H0 x 536) x C36	5,095	194.8	7,288	26.1	13.94	124
Y617H31	(562H0 x 718) x C16	4,985	205.0	6,977	24.3	14.36	118
617H36	(522H0 x 536) x C17	4,778	202.6	6,738	23.7	14.25	123
217H62	(564H0 x 536) x C17	4,749	198.6	6,750	24.0	14.10	140
E536H31	(562H0 x 718) x C36	4,697	191.6	6,779	24.6	13.81	114
617H29	(718H0 x 536) x C17	4,454	187.2	6,484	23.8	13.62	117
Test Mean		5,166	200.5	7,303	25.8	14.17	124
LSD (.05)		587	10.8	764	2.6	0.44	--
Coefficient of Variation (%)		14	6.7	13	12.4	3.82	--
Standard Error of the Mean		211	3.9	274	0.9	0.16	--
F value		3.40**	3.14**	3.30**	3.05**	3.17**	--

DATA ON U.S.D.A. VARIETIES TESTED BY SPRECKELS SUGAR COMPANY

Test Areas:	Spreckels, Calif.			Woodland, Calif.			Mendota, Calif.		
VARIETIES	Sugar T/A	Beets T/A	% Sugar	Sugar T/A	Beets T/A	% Sugar	Sugar T/A	Beets T/A	% Sugar
USH9B1 546H4 x C413	3.025	33.45	9.0	3.23	31.1	10.4	2.94	21.0	14.1
617H11 8551H4 x C17	2.474	34.87	7.1	3.01	30.4	9.9	2.41	18.2	13.4
617H36 3536-97H22 x C17							2.60	18.3	14.2
617H29 3536-97H72 x C17									
E637H8 F70-546H3 x E537	2.965	36.12	8.2	3.28	30.4	10.8	3.53	24.8	14.2
E638H8 F70-546H3 x E538	2.593	31.71	8.2	3.41	32.2	10.6	3.01	21.3	14.1
Y643H8 F70-546H3 x C43	2.381	30.96	7.7	3.10	29.2	10.6			
Y644H8 F70-546H3 x C32	2.801	36.75	7.6	3.62	33.2	10.9			
Y631H8 F70-546H3 x C31									
E506H33 546H72 x E406							3.16	22.1	14.4
E536H33 546H72 x C36									
E506H31 718H3 x E406				3.41	32.5	10.8			
E536H31 718H3 x C36							1.87	13.7	13.8
Y501H29 3536-97H72 x 401A	3.529	36.68	9.6						
Y631H8 F70-546H3 x C31	3.350	35.43	9.5						
513-5H12 546H4 x 417-1	3.271	36.12	9.0						
Y522H29 3536-97H72 x Y422	3.238	35.24	9.2						
USH10B1 546H4 x C817				3.11	30.8	10.1	2.51	17.9	14.1
GENERAL MEAN	3.047	34.84	8.7	3.40	30.9	11.0	2.63	18.6	14.1
LSD @ P = .05	0.267	1.78	0.6	.364	NS	.6	0.68	4.7	NS
LSD @ P = .01	0.349	2.32	0.8	.482	NS	.8	0.90	6.2	NS
S E of Mean	0.0971	0.6472	0.2141	.130	1.199	.225	0.242	1.664	0.283
S E in % of Mean	3.19	1.86	2.45	3.82	3.88	2.04	9.20	8.93	2.01
No. Varieties in Test		12			16			16	
Planting Date		12/15/76			5/4/77			3/1 77	
Harvest Date		9/6/77			10/12/77			10/13/77	

WILLCOX, ARIZONA

VARIETY	DESCRIPTION		Sugar T/A	Beets T/A	% Sugar
U.S.H9B1	546H4	x C413	1.355	14.79	9.1
	741039H3 662019s1	x FC701/5	1.665	15.46	10.7
	741047H5 (652016s1 x 662019s1)	x FC702/5	1.860	15.63	11.9
HA7711	751120H02 FC(504 x 505/2)	x FC605	1.628	13.56	12.0
HA7712	751102H02 (652016s1 x 662019s1)	x FC605	1.606	13.68	11.7
HA7713	741039H5 (652016s1 x 662019s1)	x FC701/5	1.444	13.36	10.8
HA7714	741040H3 662019s1	x FC702/5	2.011	16.55	12.1
GENERAL MEAN			1.706	15.08	11.3
LSD @ P = .05			.303	2.51	.6
LSD @ P = .01			.402	3.33	.8
S E of MEAN			.107	.891	.222
S E % of MEAN			6.31	5.91	1.97
No. Varieties in Test				12	
Planting Date				3/16/77	
Harvest Date				11/77	

Studies of Interspecific Hybridization in *Beta* Species

M. H. Yu

Cercospora Leaf Spot Resistance in the Wild Beets

A group of fully grown wild beets, including *Beta patellaris*, *B. procumbens* and *B. webbiana*, was tested for *Cercospora* leaf spot resistance. Isolates C5-R1 and T1-R1 of *C. beticola* were used in this screening. Inoculum was produced by culturing the isolates on sugarbeet leaf extract agar at 15° C with fluorescent light for 7 days. The inocula for inoculating plants were prepared by adding 10 ml of distilled water to each culture and gently agitating the surface of the colonies with a bent glass rod. Spore concentration was adjusted by dilution with water to 30,000 spores per ml. The inoculum was applied with an atomizer until leaves were wet. The inoculated plants were placed in a humidity chamber that maintained at 95 to 100 percent humidity and about 22° C temperature for 72 hours. Plants were then returned to the greenhouse benches and maintained at 32° C temperature for 3 weeks.

Definite leaf spot lesions were generally not shown on the leaves of the wild beets. Samples of the possible infected leaves were selected 3 to 4 weeks after inoculation. The collected leaves were sterilized with 0.5% sodium hypochlorite solution for 5 minutes and incubated under moist condition at 15° C for 6 days to induce sporulation. With the use of a dissecting microscope the lesion areas on the leaves were examined. Plants that had *Cercospora* hypha and conidia grown on the leaves were considered to be susceptible to the fungus. As shown in Table 1, most of the wild beet plants under study have been classified to be nonresistant. In this test, preparation and application of the inocula were conducted with the help of Dr. E. D. Whitney.

Small amounts of seed from most of these wild beet strains are being produced for the National Seed Storage Laboratory, Fort Collins, Colorado, for germplasm preservation.

Meiosis of a Nematode Resistant Diploid Sugarbeet

The diploid sugarbeet, culture 51501, with resistance to the cyst nematode was recovered from the progenies of resistant trisomics (alien monosomic addition lines). This plant was placed in an isolated chamber to get controlled pollination from nematode susceptible diploid sugarbeet. The meiotic chromosomal behavior of this plant was not normal and gave univalents, laggards, dicentric bridges, acentric fragments, precocious separation, sticky disjunction, restitution nuclei, and carry-over AI bridges (Table 2).

The occurrence of two independent bridges and fragments at both the first and second division indicates that two paracentric inversions were probably present in heterozygous condition in this plant. At the present, however, whether these inversions had any interrelation with the nematode resistance is not known. Because cell plates do not form in sugarbeet after the completion of the first meiotic division, portions of anaphase I bridges

persisted in the second division to become carry-over AI bridges. The carry-over bridges orient meiosis II configurations in various shapes depending on the moving direction of the daughter nuclei which separated at anaphase II. If no anaphase II bridge occurred in either second division figure, the attenuated carry-over bridge could easily be mistaken as one anaphase II bridge. For this reason, carry-over AI bridges would likely be overlooked in sporocytes of those genotypes that have only one meiotic bridge involved.

Nuclear restitution occurred in either the first or second division, or both; consequently, diploid and tetraploid gametes were produced. It should be mentioned that dependent on whether the restitution occurred at the first or second division in sugarbeet 51501, unreduced gametes containing a single, none, or double dosage of nematode resistance factor could be formed. One triploid (27 chromosomes) progeny with resistance to nematode that had been identified presumably occurred from the fertilization of such unreduced egg by a haploid pollen.

Univalents and their precocious movement to the poles may have resulted from asynapsis (lack of pairing) or desynapsis (possibly caused by a failure of chiasma formation) of bivalents. They may be caused by the presence of a transposed segment (presumably from a B. procumbens chromosome) in one member of the bivalent(s). The size of the translocated or inserted segment could depend on the structure and comparative length of the monosomic addition chromosome, the point(s) of crossover, and the location of the gene(s) on the donor chromosome. The resultant heteromorphic bivalent(s) may or may not be easy to detect. Greater length of such segment gives higher possibilities that univalents may result from lack of homology. Univalents and laggards are sources of micronuclei. If they are excluded from nuclei at the quartet stage, abortive gametes likely are produced.

Approximately 25% of the pollen grains were aborted in this plant. The transmission rate of nematode resistance was estimated to be 11.5% from the seed parent.

Transmission of Nematode Resistance Through Pollen of the Resistant Trisomics

Seeds of diploid nematode susceptible plants that were pollinated by nematode resistant alien addition lines have been harvested in previous years. Progenies were tested for nematode resistance. Among these seedlings, 1,415 plants had gamma-ray treated (at various early meiotic stages) pollen parents (the 19-chromosome resistant sugarbeets) and the other 2,230 plants were from nontreated parents. Only one resistant plant was selected from the latter group. This represents 0.03% (= 1/3,645) nematode resistance transmission through pollen of the 19-chromosome resistant sugarbeet. This plant is being maintained to conduct further study.

Table 1. Test of *Cercospora* leaf spot susceptibility of the wild beets.

Species	No. of Plants Tested*		
	Total	Resistant	Susceptible
B. patellaris	123 (21)	2 (2)	121 (21)
B. procumbens	148 (11)	1 (1)	147 (11)
B. webbiana	34 (6)	1 (1)	1 (1)

*Figures in parentheses are numbers of strains involved.

Table 2. Meiotic chromosomal behavior at anaphase I and telophase II in the diploid nematode resistant sugarbeet 51501.

Stage	Configuration	Frequency	%
Anaphase I	Normal	520	72.22
	1 or more fragments	19	2.64
	1 or more laggards	15	2.08
	1 dicentric bridge	104	14.44
	1 bridge/fragment(s)	53	7.36
	2 bridges/fragment(s)	9	1.25
		720	100 %
Telophase II	Normal	453	64.26
	1 micronucleus	34	4.82
	2 or more micronuclei	52	7.38
	1 dicentric bridge	38	5.39
	1 bridge/micronucleus(i)	59	8.37
	2 bridges/micronucleus(i)	9	1.28
	Restitution nucleus(i)	36	5.11
	Sticky disjunction	8	1.13
	Carry-over AI bridge	16	2.27
		705	100 %

INTERSPECIFIC HYBRIDIZATION

VULGARIS-PROCUMBENS HYBRIDS

Helen Savitsky

The diploid nematode-resistant plants grown in the greenhouse have well-developed foliage, good roots, and cannot be distinguished from normal sugarbeets. The diploid nematode-resistant plants are more resistant than the trisomics. The diploid plants had no more than five or six females on the roots. The majority of the diploid resistant plants had from none to three females after three tests. Nematode resistance in diploid plants almost equaled the resistance of B. procumbens. The rate of resistance transmission from diploid nematode-resistant plants is not yet sufficient. The 1976 experiments indicated that resistance is transmitted by female gametes, and at a lower frequency by male gametes. Transmission of resistance by pollen makes it possible to develop homozygous nematode-resistant lines. The development of homozygous nematode-resistant lines is very important because all offspring of such lines will be resistant and the development of nematode-resistant varieties will be greatly facilitated. In 1977, the work was concentrated on selection for an increased resistance transmission rate by female and male gametes including the study of transmission rate by pollen during two generations and the development of homozygous nematode-resistant lines.

The following experiments were conducted in 1977:

(1) New crosses were made between nematode-resistant and nematode-susceptible plants with the objective of increasing the transmission rate. In the F_1 progenies of eight nematode susceptible plants pollinated by nematode resistant plants, 12.3 percent of the plants were resistant (Table 1). From 6.3 to 17.2% resistant plants were found in these progenies. The F_1 progenies of three reciprocally crossed plants have been tested. The average transmission by the female in the progenies of nematode-resistant plants was 24.5%, and in the progenies of susceptible plants transmission by the male was 12.1% (Table 1). One plant had a high female transmission rate of 32.8% and one plant a high male transmission rate of 19.4%. To study the transmission rate by pollen during two generations the F_1 nematode-resistant hybrids obtained in 1976 from pollen transmission were used as backcross pollinators for nematode-susceptible plants. The percent of nematode-resistant plants in the B_1 progenies of nematode-susceptible plants indicates the transmission rate by pollen during two generations. Progenies of nine nematode-susceptible plants have been tested for resistance. The average rate of resistance transmission by male to the B_1 generation was 13.9% which is a little higher than to F_1 hybrids (Table 2).

In two reciprocal crosses of F_1 resistant plants derived from pollen transmission with nematode-susceptible plants the progenies of both hybrid plants were tested for resistance. These reciprocal

crosses showed a little higher rate of transmission by male and female gametes than was observed in F_1 hybrids. The average rate of transmission by male gametes was 14.6% in the progenies of susceptible plants. In the progenies of F_1 nematode-resistant plants the average transmission rate by female gametes was 25.4% (Table 2).

The following conclusions may be drawn from these experiments: 1) Selection for a higher rate of resistance transmission slightly increased the rate of transmission in the F_3 generation. 2) The average rate of transmission by pollen was approximately one-half the transmission rate by female gametes. 3) Selection for transmission by pollen during two generations slightly increased the transmission rate from the F_1 to the B_1 generation. 4) The highest observed transmission rate by female gametes was 32.8% compared with 19.4% by male gametes.

(2) To obtain self-fertile homozygous lines, the nematode-resistant plants were crossed with curly top resistant inbreds. From F_1 progenies of these crosses, 202 nematode-resistant plants were selected. Selfed seeds have been obtained from 117 of these plants. To obtain self-sterile homozygous lines 162 nematode-resistant F_3 plants were crossed in pairs. The F_4 progenies obtained from hybridization of self-sterile beets are being tested for resistance.

The cytological study of nematode-resistant plants is continuing.

Table 1. Transmission of nematode-resistance to F_1 hybrids

Transmission by male		Transmission by female	
Total F_1 plants	Percent resistant plants	Total F_1 plants	Percent resistant plants
418	12.3		
	Reciprocal crosses		
190	12.1	155	24.5

Table 2. Transmission of nematode-resistance to B_1 plants

Transmission by male		Transmission by female	
Total B_1 plants	Percent resistant plants	Total B_1 plants	Percent resistant plants
536	13.9		
	Reciprocal crosses		
130	14.6	110	25.4

VULGARIS-COROLLIFLORA HYBRIDS

Helen Savitsky and J. S. McFarlane

Seeds were obtained from all curly top resistant plants selected in 1976 after inoculation with a virulent strain of curly top virus. Plants from these seeds are being tested for curly top resistance and resistant plants will be selected.

FUSARIUM STALK BLIGHT RESISTANCE

J. S. McFarlane

The male sterile parents 562 CMS and 563 CMS are very susceptible to Fusarium stalk blight. These lines are used as parents in US H9, US H10, and several company-developed varieties. Work has been underway during the past three years in cooperation with the West Coast Beet Seed Company to incorporate stalk blight resistance into a 563 type inbred. The 563 line was developed by crossing NB1 to the original 101 monogerm and then back-crossing to NB1. During the backcrossing procedure, many of the desirable characteristics of NB1 were incorporated but susceptibility to Fusarium stalk blight was apparently carried over from the 101 monogerm line. In 1976, selections for the monogerm character and Fusarium stalk blight were made in an F_2 population from an additional backcross between 563 and NB1. These selections were tested at Salem for stalk blight resistance in 1977 and seed increases were made in the greenhouse at Salinas. All of the selections were more resistant than 563 and several of them were superior to NB1. Increases of the best lines are being made at Salem in 1978 and hybrids are being produced with 563 CMS.

A group of 30 inbreds, open-pollinated lines, and hybrids were also evaluated at Salem in 1977. Damage ranged from almost zero for the NB4 inbred to complete death of the 562 inbred (Table 1).

Table 1
FUSARIUM STALK BLIGHT RESISTANCE TEST
Salem, Oregon, 1976-77
Planted August 28, 1976 - Rated August 8, 1977

Entry	Description	Grade[1]
6554	Inc. NB4 inbred	0.09
5118	502aa x 5522-29	0.09
6563	Inc. S_{14} 563 inbred	0.2
1502H0	NB1 (CMS)	0.4
6502aa	502aa x 3502Aa	0.4
1502	NB1	0.5
F70-13	Pollinator for US H10	0.7
5126	502aa x 3536-97	0.7
5522-29H0	522 (CMS)	0.9
6522-29	522 inbred	1.0
F70-546	546 inbred	1.0
5522-29H1	3536-97H0 x 4522-29	1.0
6564H1	(502H0 x 563) x 4564C1	1.2
604-23	CTRS Y804	1.7
604-13	CTRS Y804	1.8
F69-546H4	563H0 x F66-546	1.9
5551	551 inbred	2.0
F66-562	562 inbred	2.0
F69-546H5	564H0 x F66-546	2.0
F67-563H0	563 (CMS)	2.2
F67-569H3	562H0 x 569	2.7
5564Aa	4564mmaa x 4564C1	2.8
4536-97	536 inbred	2.9
F67-563	563 inbred	2.9
5551H5	F67-564H0 x 8551	3.1
604-15	CTRS Y804	3.3
5564	564 inbred	3.6
6564Aamm	1564aa x 4564C1	3.6
3565	565 inbred	3.7
6562	Inc. S_{13} 562 inbred	4.0
6564H0	4564H0 x 5564	4.0

1/ Stalk blight rated on a scale of 0 to 4
with 0 = no disease and 4 = dead plant.

Results of USSR Tests with American Sugarbeet Varieties

J. S. McFarlane

Following a trip to the Soviet Union in 1972, arrangements were made to exchange seed of variety and breeding lines. We provided seed of 25 varieties developed by both the USDA and sugar company breeders. The Russians sent us seed of 25 varieties developed at breeding stations throughout the sugarbeet producing areas of the Soviet Union. Results of our tests with the Russian varieties were summarized in "Sugarbeet Research, 1974 Report." Attempts to obtain results of Russian tests with American varieties through the USSR agricultural counselor in Washington, D.C. were unsuccessful. During a visit at the All Union Research Institute for the Sugar Industry at Kiev in October 1977, I was provided with a summary of 1975 tests with American varieties. A translation of the Russian report by Dr. Helen Savitsky follows.

In 1975 tests were made with 25 American sugarbeet varieties at four research stations belonging to the All Union Research Institute for the Sugar Industry. These varieties were received by the Institute from the All Union Institute of Plant Industry in Leningrad, August 20, 1974. The germination of these varieties varies from 43% for the variety S501H2 to 95% for the variety UI H7.

The results show that in most tests the American varieties were less productive than the standard Ramon 06 variety and the varieties approved for planting in the various districts.

Many American varieties were superior in Cercospora and root rot resistance, but some of them were lower than the standard in resistance to mildew, virus yellows, and trench rot.

Uman Breeding Station in the Cherkas District

Twenty-five American varieties were tested. Nineteen varieties were placed in the Series No. 13 test and six varieties in the Series No. 15 test, Table 1. The American varieties were lower in yield and sugar than were the multigerm Ramon 06 variety and the Verkhnyachskaya 103 variety. The American varieties UI Hybrid 8, UI Hybrid 3, and HH21 were more productive than the monogerm variety Yaltushkovskaya.

All American varieties were less resistant to powdery mildew and a little more resistant to Cercospora leaf spot than were the Russian varieties. Twelve of the American varieties were more resistant to virus yellows and 13 were less resistant than the Yaltushkovskaya monogerm variety.

Yaltushkovskaya Breeding Station in Vinnitsa District

Twenty-five American varieties were tested. The results, Table 2, show that American N3 Hybrid A, S501H2, HH10, S701H1, and HH25 were 0.3 to 4.4 centner higher in sugar yield than was the Yaltushkovskaya monogerm. All the American varieties were superior in Cercospora resistance and 14 of them were also superior in powdery mildew resistance.

Ivanovskaja Breeding Station in the Sunskoy District

Fourteen American varieties were tested. All of the American varieties were less productive than the Soviet standards Yaltushkovskaya monogerm and Ramon 06, Table 3. One American variety, AH-4, was higher in sucrose than the Yaltushkovskaya monogerm by 0.4% but it was low in beet yield. All American varieties tested in the Sunskoy District were more resistant to Cercospora and equalled Ramon 06 in powdery mildew resistance. All American varieties were lower in trench rot resistance.

Lgov Breeding Station in the Kursk District

Ten American varieties were tested. The accuracy of the experiments was low and all data were discarded.

Table 1
Uman Location in the Cherkas District, 1975

	Root Yield cent/ha	% Sucrose	Sugar Yield cent/ha	Order	Disease Infection Cercospora	Mildew	Virus Yellows
			No. 13 Series of the Main Tests				
Ramon 06	292	21.5	62.8	1	1.8	50	1.24
Verkhnyachskaya 103	294	21.1	62.0	2	0.6	12	0.62
UI Hybrid 8	267	21.4	57.1	3	0.3	81	0.84
UI Hybrid 3	255	21.7	55.3	4	0.3	75	0.31
HH21	254	21.3	54.1	5	0.8	44	0.87
Yaltushkovskaya mm	254	21.0	53.3	6	2.0	10	0.81
HH19	250	20.9	52.2	7	0.6	22	1.11
S101H12	247	21.1	52.1	8	1.3	32	0.48
HH23	245	20.9	51.2	9-10	0.6	29	1.71
HH25	238	21.5	51.2	9-10	1.3	75	0.96
American No. 3 Hybrid A	247	20.6	50.9	11	1.3	25	1.12
Mono-Hy A1	250	20.1	50.2	12	0.6	21	1.22
Mono-Hy D2	235	21.2	49.8	13	0.3	22	1.02
S701H1	239	20.8	49.7	14	1.0	70	0.15
UI Hybrid 7	238	20.8	49.5	15	0.6	90	0.64
American No. 3 Hybrid N	223	20.8	46.4	16	0.3	24	0.93
AH-4	216	21.3	46.0	17	1.3	51	0.51
US H10	219	20.9	45.8	18-19	0.3	50	0.52
S501H2	220	20.8	45.8	18-19	0.3	35	0.33
American No. 4 Hybrid A	214	21.3	45.6	20	0.8	26	0.51
American No. 4 Hybrid T	202	20.7	41.8	21	0.6	18	0.53
			No. 15 Series of the Main Tests				
Ramon 06	368	22.0	81.0	1	1.8	50	1.24
Verkhnyachskaya 103	351	21.9	76.9	2	2.0	10	2.52
American No. 2 Hybrid C	339	21.4	72.5	3	0.1	16	0.15
Mono-Hy A2	325	21.4	69.5	4-5	0.6	48	1.56
HH10	325	21.4	69.5	4-5	0.3	15	1.42
US H9	337	20.6	69.4	6	1.0	50	0.74
American No. 2 Hybrid B	326	21.2	69.1	7	0.1	40	1.70
Mono-Hy E2	307	22.4	68.8	8	0.1	6	2.78

Remarks:
1. Cercospora and virus yellows infection expressed in units.
2. Mildew infection expressed in percent of diseased plants.
3. To convert centners/hectare to tons/acre multiply by .0446.

Table 2
Yaltushkovskaya Breeding Station, 1975

	Root Yield cent/ha	Order	% Sucrose	Order	Sugar Yield cent/ha	Order	Infection in % Cercospora	Infection in % Mildew
American No. 3 Hybrid A	393	3	18.4	7	72.3	1	68.9	95.8
S501H2	382	5	18.5	5-6	70.7	2	39.4	120.0
HH10	391	4	17.7	14	69.2	3	68.9	116.7
S701H1	397	2	17.3	21-22	68.7	4	45.5	112.0
HH25	401	1	17.0	25	68.2	5	79.4	87.5
Yaltushkovskaya mm	367	11-12	18.5	5-6	67.9	6	100.0	100.0
American No. 2 Hybrid B	355	14-15	19.1	1	67.8	7	51.7	116.7
HH21	377	7	17.9	9-11	67.5	8	68.9	137.5
HH23	379	6	17.6	15-17	66.7	9	99.3	87.5
Mono-Hy E2	350	16	18.9	2	66.1	10	37.1	103.4
American No. 2 Hybrid C	367	11-12	17.9	9-11	65.7	11	51.7	129.1
Mono-Hy A2	373	8	17.6	15-17	65.6	12	37.1	66.6
S101H12	371	9	17.6	15-17	65.3	13	63.7	84.0
US H20	366	13	17.8	12-13	65.1	14	62.5	113.8
Mono-Hy A1	369	10	17.5	18	64.6	15	37.1	103.4
AH-4	355	14-15	17.9	9-11	63.5	16	68.9	125.0
American No. 3 Hybrid N	347	17	18.1	8	62.8	17	40.6	93.1
American No. 4 Hybrid A	325	23	18.9	3	61.6	18	54.6	100.0
UI Hybrid 3	341	19	17.3	21-22	60.0	19	72.5	72.4
UI Hybrid 8	338	20-21	17.4	19-20	59.8	20	72.5	79.3
Mono-Hy A2	333	22	17.8	12-13	59.3	21	62.5	96.6
US H9	338	20-21	17.2	23	58.1	22	84.4	68.9
HH19	342	18	17.1	24	58.5	23	46.8	86.2
US H10	321	24	17.4	19-20	55.8	24	87.1	62.1
UI Hybrid 7	314	25	16.8	26	52.7	25	53.1	79.3
American No. 4 Hybrid T	275	26	18.6	4	51.1	26	65.6	72.4

Performance of Sugarbeet Lines and Hybrids Selected for Resistance to Erwinia

R. T. Lewellen, E. D. Whitney, and I. O. Skoyen

Breeding for resistance to soft rot of sugarbeet incited by a variety of *Erwinia carotovora* was continued in 1977. The first cycle of selection was made in 12 monogerm breeding lines and random-mating populations. A second cycle of selection was made in six multigerm breeding lines. For the first cycle of selection, normally spaced plants were injured and inoculated with mixed isolates of *Erwinia*. In October, roots without soft rot were selected from the field and then reselected on the basis of % sugar. Examples of the results of one cycle of selection are shown in the tables below. In general, each cycle of selection has been effective at reducing the rot damage by about one half. The second cycle of selection was made from spaced (28") injury-inoculated plants. In the eight-to-ten leaf stage these plants were inoculated with BWYV and in mid-August with *Erwinia*. Concurrently then, selection was practiced for resistance to virus yellows and *Erwinia* by selecting the beets with the highest gross sugar yield among nonrotted roots. This concurrent selection scheme appeared to work well for the second cycle of selection but when previously attempted for a first cycle of selection did not work because of too few nonrotted roots.

A hybrid with good resistance to *Erwinia* with the experimental designation of C36H8 has shown promise as a replacement for more susceptible US H9 and US H10 (see tabular data below). The higher level of resistance of C36H8 is bestowed by its pollinator, C36. C36 was selected from highly susceptible C13 and was released to sugarbeet breeders in 1977. In addition, a sister selection, C02, also was released. In field tests at Salinas, Brawley, and in cooperation with sugar company researchers, C36H8 was essentially equivalent to US H10B but showed only about 1/8 the damage from soft rot in both naturally infected and injury-inoculated tests. Unless unforeseen problems arise, C36H8 is being recommended as a replacement for US H9 and US H10 type hybrids.

When the sugar yields of US H10B and C36H8 were compared to the grand mean of all entries in 15 yield trials conducted during 1976 and 1977 at Salinas, Brawley, Tracy, Clarksburg, and Mendota, they averaged only 99.1 and 102.2%, respectively. These tests were composed of 10 to 26 entries and primarily included new experimental hybrids composed of breeding lines developed at Salinas in the curly top and virus yellows resistance programs. What we believe this comparison shows is that our breeding program is successful at developing new, higher yielding, more disease resistant breeding lines. However, many of these new experimental breeding lines and hybrids have one or more major deficiencies at this time that limit their commercial utilization. One of the striking deficiencies of many of these breeding lines is their susceptibility per se and in certain hybrid combinations to *Erwinia*. As a result of additional funding from the California Sugarbeet Industry Research Committee, a more intensive breeding program was initiated in 1975 to upgrade the level of resistance to *Erwinia* in our breeding lines and germplasm. Through the continuation of this program, we hope to reduce the vulnerability of new developments to *Erwinia* and remove this constraint on the use of more productive parental lines and hybrids.

The results of the field studies on resistance to *Erwinia* are summarized in the following tables:

SUMMARY OF REACTION OF HYBRIDS TO ERWINIA, 1976-77

Hybrid	Description	% Roots with Rot*	% Rot per Root**
US H7A	(562HO x 546) x C64	2.1	7.1
US H9B	(" x ") x C13	--	22.3
US H10B	(" x ") x C17	8.6	23.4
C36H8	(" x ") x C36	1.1	3.7

* Natural infection. Roots with rot counted at harvest in Salinas and Brawley yield tests.
** Injury-inoculated tests (mean of 3 tests). Equals Σ% rot/no. of roots where each root was scored on a scale of 0, 1(VN), 7, 25, 75, 93, and 100% rot.

SUMMARY OF REACTION OF POLLINATOR LINES TO ERWINIA, 1976-77

Pollinator	% Roots with Rot*	% Rot per Root**
C64	1.0	9.3
C13	--	56.3
C17	22.6	53.2
C36	0.4	4.1

* Natural infection. Roots with rot counted at harvest in Salinas and Brawley yield tests.
** Injury-inoculated tests (mean of 3 tests).

SUMMARY OF REACTION OF MONOGERM PARENTAL LINES TO ERWINIA, 1976-77

Line	Description	% Rot per Root*
C562HO	Monogerm inbred	17
C563HO	" "	20
C546	" "	6
C562HO x C546	Monogerm F_1 hybrid	12

* Injury-inoculated tests (mean of 2 tests).

EXAMPLES OF REACTION OF MONOGERM
BREEDING LINES TO ERWINIA, 1976-77

Line	Description	% Rot per Root*
C536	Monogerm inbred	26
C522	" "	32
C705	" "	40
C706	" "	26
C718	" "	31

* Injury-inoculated tests (mean of 2 tests).

EXAMPLES OF EFFECT OF ERWINIA RESISTANT SELECTION
ON REACTION OF BREEDING LINE TO ERWINIA, 1977

Line	Description	% Rot per Root*
C13		56
C36	3 cycles of selection	4
C17		53
E37	1 cycle of selection	29
C31		37
C31E	1 cycle of selection	14

* Injury-inoculated tests.

% LOSS TO VIRUS YELLOWS, 1976-77

		1976 (BYV-BWYV)*		1977 (BWYV)**
Pollinator-Hybrid		Pollinator	Hybrid	Pollinator
C17	-US H10B	15.9	31.4	6.4
C13	-US H9B	30.4	39.3	6.8
C36	-C36H8	31.2	35.6	10.6
US 75	--	50.5	--	24.8

* Extracted from tests 1176-1, 1176-2.
** Extracted from test 1577.

USDA ENTRIES TESTED FOR REACTION TO ERWINIA
AT WOODLAND BY SPRECKELS SUGAR COMPANY, 1977

Entry	Description	% Resistant Roots	% Rot per Root
C13		14.5	82.7
C36	ERS C13	74.7	20.8
US H9B1	546H4 x C13	31.0	66.9
Y601HL13	(718H0 x 779) x C01	42.0	50.1
Y601HL17	5796-1H2 x C01	35.1	57.2

Planted May 5, 1977; inoculated June 16, 1977; rated for rot October 3-4, 1977.
Plot became very dry for short period and may have influenced ratings for rot damage.

SUMMARY OF THE COMPARATIVE PERFORMANCE OF HYBRIDS
WITH C17 AND C36 POLLINATORS, 1976-77

Hybrid	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolting	Root Rot[1/]
		Pounds	Tons	Percent	Percent	Percent
GRAND MEAN OF 16 TESTS						
C17 (C13) Hybrids		9,850	37.80	13.07		
C36 Hybrids		10,040	38.09	13.20		
Test 677. Salinas, 1977, 10 reps, 2-row plots, 30 ft long						
US H10B	546H3 x C17	11,080	39.68	13.99	0.1	4.5
E36H8	" x C36	11,100	39.53	14.09	0.4	0.7
		NS	NS	NS	NS	**
Test 777. Salinas, 1977, 8 reps, 2-row plots, 30 ft long						
C17H29	536H72 x C17	12,050	42.30	14.31	0.0	14.4
E36H29	" x C36	11,730	40.91	14.38	0.2	1.7
		NS	NS	NS	NS	**
Test 1277. (Noninoculated) Salinas, 1977, 8 reps, 1-row plots, 30 ft long						
C17H80	718H5 x C17	14,230	53.34	13.40		4.4
C36H31	718H3 x C36	14,030	52.67	13.34		1.0
		NS	NS	NS		NS
Test 1277. (BWYV infected) Salinas, 1977, 8 reps, 1-row plots, 30 ft long						
C17H80	718H5 x C17	12,400	49.36	12.60		10.0
C36H31	718H3 x C36	11,370	45.10	12.61		0.4
		**	**	NS		**

SUMMARY OF THE COMPARATIVE PERFORMANCE OF HYBRIDS WITH C17 AND C36 POLLINATORS, 1976-77

Hybrid	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolting	Root Rot[1/]
		Pounds	Tons	Percent	Percent	Percent
Test B177. Brawley, 1977, 10 reps, 2-row plots, 40 ft long						
US H10B	546H3 x C17	9,280	33.65	13.79	1.6	
C36H8	" x C36	9,320	34.04	13.69	4.1	
		NS	NS	NS	**	
Holly 11901-1. Imperial Valley, 12 reps, 1-row plots, 25 ft long						
C17H29	536H72 x C17	6,480	23.8	13.62		
C36H29	" x C36	7,290	26.1	13.94		
		*	NS	NS		
Test 576. Salinas, 1976, 4 reps, 2-row plots, 32 ft long						
US H10B	546H3 x C17	9,840	34.74	14.20	18.2	0.7
C36H8	" x C36	10,560	36.87	14.34	19.9	0.8
		*	NS	NS	NS	NS
Test 776. Salinas, 1976, 8 reps, 2-row plots, 32 ft long						
US H10B	546H3 x C17	10,780	40.25	13.41		2.5
C36H8	" x C36	10,630	40.43	13.18		1.3
		NS	NS	NS		NS
Test B176. Brawley, 1976, 10 reps, 2-row plots, 40 ft long						
US H10B	546H3 x C17	8,550	33.76	12.67	5.8	7.6
C36H8	" x C36	9,190	36.47	12.61	9.5	0.5
		*	**	NS	*	**
Test 1176-1. (Noninoculated) Salinas, 1976, 6 reps, 1-row plots, 41 ft long						
US H10B	546H3 x C17	11,190	43.06	12.94		2.2
C36H8	" x C36	12,160	44.91	13.55		0.3
		NS	NS	NS		**
Test 1176-1. (BYV-BWYV infected) Salinas, 1976, 6 reps, 1-row plots, 41 ft long						
US H10B	546H3 x C17	7,500	30.07	12.47		
C36H8	" x C36	7,840	30.94	12.66		
		NS	NS	NS		
Holly 13906-2A. Tracy, 1976, 9 reps, 1-row plots, 21 ft long						
US H10B	546H3 x C17	9,400	37.7	12.45		
C36H8	" x C36	9,770	39.3	12.46		
		NS	NS	NS		
Holly 13907-2B. Tracy, 1976, 9 reps, 1-row plots, 21 ft long						
US H10B	546H3 x C17	10,380	35.8	14.46		
C36H8	" x C36	10,370	36.3	14.18		
		NS	NS	NS		

SUMMARY OF THE COMPARATIVE PERFORMANCE OF HYBRIDS
WITH C17 AND C36 POLLINATORS, 1976-77

Hybrid	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolting	Root Rot 1/
		Pounds	Tons	Percent	Percent	Percent
ACS 624-3(I). Clarksburg, 1976, 8 reps, 25 ft plots						
US H10B	546H3 x C17	7,150	28.6	12.4		
C36H8	" x C36	7,740	27.9	13.9		
		NS	NS	**		
Spreckels. Spreckels, 1976						
US H9B1	546H4 x C13	8,330	42.35	9.8		
C36H8	546H3 x C36	7,850	39.33	9.6		
		NS	*	NS		
Spreckels. Mendota, 1976						
US H9B1	546H4 x C13	9,020	36.4	12.4		
C36H8	546H3 x C36	9,700	38.6	12.6		
		NS	NS	NS		

1/ % roots with Erwinia soft rot at harvest. Weighed but not included in sugar sample for Salinas and Brawley tests. Therefore, % sucrose in most tests is biased upward for US H10B in comparison to C36H8.

EVALUATION OF BREEDING LINES AND HYBRIDS TO ERWINIA ROOT ROT, 1977

		Test 2177. Spence[1/]			Salinas, CA[2/]		
Variety	Description	DI[3/]	% Healthy[4/]	No. of Roots	DI	% Healthy	No. of Roots
464	Inc. F66-64	2.1	90.7	54	12.8	69.5	118
F70-13	Inc. F66-13(0268)	41.7	30.6	49	58.4	14.9	134
E502	Inc. E402,-4,-5	4.4	90.0	50	7.6	84.2	121
E602(C02)	ERS E402	7.1	87.8	41	7.9	70.8	113
E506(Sp)	Inc. E406	0.5	97.3	38	3.9	81.9	116
E606	ERS E406	0.8	95.7	47	14.2	68.4	117
E634	ERS E434	2.0	90.4	42	2.9	84.5	116
E536(C36)	Inc. E402,5,6,34	1.2	90.9	44	5.4	83.2	119
E540	ESS F70-13	57.8	10.4	48	83.1	0.9	112
417(Ore)	Inc. 713A(C17)	54.4	24.5	57	64.1	18.2	110
517T	Inc. 117T(C17T)	60.7	22.2	54	85.1	4.6	108
623-5E(C23)	ERS 417-1	26.4	57.1	56	33.3	44.1	127
E637	Inc. E537	26.2	64.2	53	28.5	50.8	120
E638	Inc. E538	20.8	64.6	48	36.1	42.6	122
E639	Inc. E539	11.0	76.0	50			
Y601	Inc. Y401A(C01)	24.4	51.2	43			
Y631	Inc. Y331	26.0	58.3	48	46.2	27.9	122
Y631E(C31)	ERS Y231	8.1	82.0	50	20.1	57.1	119
Y640	ERS Y440	5.4	82.0	61	12.6	62.9	124
Y641	ERS Y441	6.8	79.3	58	9.6	75.0	120
Y642	ERS Y442	3.3	84.3	51	12.5	72.7	121
Y646	ERS 4219	7.2	81.8	55	14.3	61.3	111
Y633	ERS Y233	19.5	62.9	62			
Y639	ERS Y439	8.9	81.0	58			
Y643	Inc. 5202	23.8	49.2	59			
Y644	Inc. 4247	5.0	85.2	61			
Y630	Inc. Y430	12.4	72.1	61			
468	Inc. 868(US 75)	9.8	78.0	59			
Y522(C22)	Inc. Y422	36.8	30.4	56			
Y523	Inc. Y423	12.8	67.9	53			
Y526	Inc. Y426	5.2	88.3	60			
6224	Inc. 5244Cb-	26.5	53.3	60			

1/ 1-row plots, 21 ft. long, 2 replications. Planted 5/11/77. Injury-inoculated 7/21/77. Harvested and scored 11/1-3/77.

2/ 1-row plots, 20 ft. long, 4 replications, RCB. Planted 5/2/77. Injury-inoculated 7/12/77. Harvested and scored 10/3-4/77.

3/ DI = Disease Index = Σ % rot/no. of roots. Roots scored on a scale of 0, 1(VN), 7, 25, 50, 75, 93, and 100% rot.

4/ % healthy = number with 0, VN x 100/total.

EVALUATION OF BREEDING LINES AND HYBRIDS TO ERWINIA ROOT ROT, 1977 cont.

		Test 2177. Spence[1]			Salinas, CA[2]		
Variety	Description	DI[3]	% Healthy[4]	No. of Roots	DI	% Healthy	No. of Roots
Y617	Inc. Y517-T-O-Sel.	38.5	38.6	57			
Y617HO	Y517HO x Y517-T-O	35.3	31.1	61			
6227	Inc. 5223RY	19.3	50.8	65			
6228	Inc. 5224RY	55.6	14.5	62			
504-6	CTRS Y04	9.1	58.8	17			
504-9	CTRS Y04	20.5	33.3	30			
504-23	CTRS Y04	14.1	67.7	31			
604-13	CTRS Y04	23.3	46.4	28			
604-15	CTRS Y04	49.2	16.6	24			
US H7A	F70-546H3 x F66-64	6.4	80.7	57	7.7	75.0	128
US H9B	546H3 x F68-13(9034)	22.1	46.8	47	22.4	41.0	122
E402H8	F70-546H3 x RR 9	3.0	85.9	64	7.9	66.7	123
E602H8	546H3 x C02	2.8	83.3	54	6.0	77.5	120
E506H8	F70-546H3 x E406,-2,...	2.2	91.5	59	6.6	82.2	129
E606H8	546H3 x ERS E406	2.1	94.4	54	3.5	81.6	125
E536H8	F70-546H3 x C36	0.6	93.7	64	3.2	82.3	124
US H10B	546H3 x C17(3084)	18.0	58.0	62	17.9	46.6	133
US H10A	569H3 x C17(1231)	20.1	49.0	55			
417TH8	F70-546H3 x C17T	36.9	30.7	52	41.9	25.6	125
D2	GW's Mono-Hy D2	16.9	61.2	62			
US H20	mm x SP6822-0	10.9	74.1	62			
Y601H8	F70-546H3 x C01	10.2	67.2	58			
Y631H8	F70-546H3 x C31	17.5	58.9	56			
617H11	8551H4 x C17	16.0	49.2	65			
617H36	3536-97H22 x C17	29.0	25.7	66			
E506H29	3536-97H72 x E406,-2,..	5.8	76.6	60	6.7	73.1	119
E536H29	3536-97H72 x C36	6.4	81.8	55	7.5	62.1	124
517H29	3536-97H72 x C17	31.2	25.9	54	43.4	15.8	127
517TH29	3536-97H72 x C17T	34.5	25.3	63	44.0	17.4	132
Y601H29	3536-97H72 x C01	19.8	44.0	50			
Y631H29	3536-97H72 x C31	30.4	37.0	54			
617H31	3718H3 x C17	35.9	25.4	55			
E637H31	3718H3 x E537	17.2	52.6	57			
E638H31	3718H3 x E538	20.1	49.0	51			
E639H31	3718H3 x E539	11.6	74.0	54			
Y601H31	3718H3 x C01	17.4	50.0	58			
Y631H31	3718H3 x C31	28.9	33.3	54			
Y601HL13	5779H72 x C01	26.9	48.1	54			
617HL13	5779H72 x C17	48.8	14.2	56			
617HL4	5744HO x C17	23.8	50.0	60			

EVALUATION OF BREEDING LINES AND HYBRIDS TO ERWINIA ROOT ROT, 1977 cont.

Variety	Description	Test 2177. Spence[1/] DI[3/]	% Healthy[4/]	No. of Roots	Salinas, CA[2/] DI	% Healthy	No. of Roots
617HL5	5745HO x C17	34.1	29.5	61			
S-445H	NB Sprex Hybrid	14.4	61.3	44			
6789A	ERS 4789	12.3	65.6	64	12.1	54.5	132
6790A	ERS 4790	5.1	83.0	65	11.6	72.1	122
6789	ERS 4789aa x A	10.9	70.1	67			
6790	ERS 4790aa x A	4.9	79.1	67			
4789	3789aa x A	19.4	54.5	55			
4790	3790aa x A	18.2	59.6	57			
5740	4740aa x A	20.7	49.1	61			
5741	4741aa x A	19.9	50.8	59			
6742	5742aa x A	13.8	70.0	60			
6744	5744aa x A(C789)	17.5	61.5	52			
6745	5745aa x A	23.2	50.0	56			
6746C1	5791B,F,G,H,I,J,Kmm⊗	13.3	56.2	48			
5791F	3791-HGS(S_1)aa x A	41.6	36.3	55			
6755	5755,Baa x A	28.5	48.2	56			
6791	4791,Daa x A	25.3	39.2	51			
6796-1	5796-1aa x A	24.5	40.0	55			
6796-2	5796-2aa x A	16.0	57.6	59			
6792	Inc. 5792 (A,aa)	39.0	29.7	47			
6793	Inc. 5793 (A,aa)	5.7	83.3	54			
6794A(Sp)	Inc. 5794-T-O-Sel.	4.5	69.3	62			
6795	Inc. 5795 (A,aa)	2.8	81.4	54			
6798	Inc. 5798 (A,aa)	46.2	20.0	45			
F70-546H3	(0036) 562HO x 546	11.9	63.7	58			
3536-97H72	C718HO x C536	20.5	52.9	51			
3546H72B	C718HO x F70-546	7.0	62.2	53			
3546H54	C706HO x F70-546	4.3	82.7	58			
3718H3(Sp)	F66-562HO x C718	10.9	71.1	52			
3718H54	C706HO x C718	18.8	46.5	58			
6551H4	C563HO x C551	5.2	77.3	66			
F69-546H4	C563HO x C546	7.6	61.7	34			
6551	C551	2.2	85.0	60			
6551HO	C551HO	6.8	68.1	66			
4536-97	C536	23.5	23.5	17			
4536-97HO	C536HO	22.4	17.5	40			
5522-29	C522	14.2	57.1	63			
F66-562HO	(6349)	12.9	64.8	54			
F66-563HO	(6486)	19.0	34.3	32			
F70-546	(0139)	5.3	72.0	43			

EVALUATION OF BREEDING LINES AND HYBRIDS TO ERWINIA ROOT ROT, 1977 cont.

		Test 2177. Spence[1]			Salinas, CA[2]		
Variety	Description	DI[3]	% Healthy[4]	No. of Roots	DI	% Healthy	No. of Roots
F71-705	Inc. C0705	43.6	13.3	45			
3705	Inc. 2705(C706)	23.2	48.2	56			
F74-718	Inc. 2718(C718)	25.8	43.7	48			
F74-718HO	C718HO x C718	31.0	28.8	59			
3718(Sp)	Inc. 2718(C718)	31.9	29.2	41			
3718HOB	C718HO x C718HO	24.3	31.4	54			
5718	Inc. C718(Iso)	32.8	25.6	39			
6719	ERS 4717	6.3	77.0	48	4.4	77.1	105
6706	Inc. 4791C1mm (A,aa)	18.5	51.4	68			
6708	Inc. 4708 (A,aa)	1.4	90.2	61			
6713	Inc. 4713 (A,aa)	12.3	69.2	52			
6730	Inc. 4730	55.1	12.7	47			
6731	Inc. 4731	53.6	24.2	33			
6733	Inc. 4733	4.8	71.9	57			
6736A	Inc. 4736	10.1	66.0	56			
6737A	Inc. 4737	3.3	81.3	43			
6758-1	Inc. 4758-1	15.9	55.7	61			
6758-3	Inc. 4758-3	39.9	28.5	63			
6770A	Inc. 4770	22.9	42.8	49			
2779	YRS 0779C1	16.0	60.3	53			

Field Evaluation of Root Toughness (Root Fiber Content) in Sugarbeet

I. O. Skoyen and R. T. Lewellen

Often during sugarbeet harvest in California the expression is heard that "this is a soft beet year" or that "this is a tough beet year." These expressions obviously refer to the ease of factory slicing of the sugarbeet crop. When beets are tough, fiber content is high. This causes difficulty in slicing the roots during processing as well as other problems. Severe and advanced bolting can cause increased slicing difficulty but this may not be a factor during "tough beet years." Decreased density of sugarbeet pulp has also been reported to be another side effect of tough beets. Apparently, the more fibrous pulp breaks up less during processing, thus increasing its bulk.

The root toughness characteristic of sugarbeet processing quality has received little attention in sugarbeet breeding because 1) research emphasis has been placed on other essential varietal attributes, such as monogerm seed type, resistance to bolting and diseases, good yield potential, and sucrose content and 2) a method of rapidly surveying root toughness in the field has not been available. Some selection pressure for less fibrous roots has occurred from observation of root-fiber content during single-root sucrose evaluation but this probably has been more incidental than intentional.

The 1977 tests include a preliminary survey of root toughness in representative lines and varieties developed at Salinas and a survey of seeding dates as a preliminary indication of environmental effects on root toughness. Also, the development of a rapid method for taking root toughness measurements on single plants in the field is reported.

Materials and Methods--The preliminary survey of root toughness was conducted in a replicated test seeded January 19, 1977. The test included 31 entries of representative multigerm and monogerm inbred lines, open-pollinated lines, and hybrid varieties developed at the U.S. Agricultural Research Station, Salinas, California. Root toughness was measured on a single plant basis for all test entries. In a second test using US H10B, root toughness and root diameter measurements were made in the field on 200 plants in each of four different seeding dates. Each seeding was also in a different field location. Toughness of MonoHy D2 was compared with that of US H10 for the March 22, 1977 seeding date.

Root toughness was measured with a modified Magness-Taylor pressure tester. The modification consisted of replacing the round probe, such as that used for testing firmness of apples, with a thin flat blade of spring steel. The blade's dimensions were 1 x 15.75mm (15.75 sq. mm cross section) and 2.54cm long. The blade was welded to a slotted head screw of the proper thread size for attaching to the shaft of the tester. Toughness was measured as lbs pressure required for the blade to penetrate a root 2.54cm (1 inch) deep. Pressure measurements of root toughness were recorded in half pound increments. Root probes were made 1 to 2 inches below the crown, and horizontally to the vertical plane of the roots. This location for probing the roots was chosen

because under our conditions this area is generally above the soil surface or the soil can be conveniently cleaned away before taking measurements. Also, preliminary probing of single beet roots at eight locations, including the crown and lateral root zones, indicated that measurements 1 to 2 inches below the crown were representative of root toughness.

Results and Discussion--The preliminary study of root toughness of representative sugarbeet breeding lines, hybrid components, and varieties developed over the past 25 years showed that there were significant differences both between and within varieties in 1977 (Table 1). As might be expected, since no selection pressure has been applied for "softer" roots, the degree of root toughness appeared to be a random occurrence among the different types of lines represented in the test. However, several inbred lines were among those having the toughest roots.

When the distribution of toughness measurements for any given entry is arranged in frequency classes (Table 1), a broad range of toughness (apparent root fiber content) occurs in all lines tested. However, refinement of the probe procedure for measuring toughness probably would narrow the toughness range somewhat. The proportion of plants in the 13- to 21-lb pressure range shows that this portion accounts for about 87% of the roots for the "softest" variety and 41% for the toughest. Among all 31 test entries, the 13- to 21-lb class accounted for nearly 71% of all roots measured for toughness. The variation exhibited between and within lines indicates that selection for less root toughness should be possible.

In a second test in 1977, root toughness was compared with seeding dates and root diameter in the commercial variety US H10B (Table 2). There were four seeding dates, about two months apart, and four different field locations. This test was also a preliminary evaluation of the environmental effects on root toughness. November seeded beets were significantly tougher than those seeded in March and May but the January seeded beets were significantly less tough than all other seeding dates. No association was indicated between root toughness and root diameter. The January and March seeded beets had slightly greater diameter than those of roots from the November and May seeded beets.

The influence of environment, although unknown, can be expected to be a major factor in root toughness. The development of varieties with less tough roots probably would tend to minimize root toughness in years with "tough beets." Also, total environmental effects probably can be expected to be composed of several interrelated factors in sugarbeet growth including soil, water, climate, fertility, and chemical effects from herbicides, fungicides, and insecticides.

Table 1: Summary of preliminary root toughness survey, 1977

Variety	Description	Type of Line or Hybrid	Total No. Roots Probed	Mean Probe Value Lbs.	Frequency distribution of root toughness Pounds Pressure 13-15	16-18	19-21	22-24	25-27	28-30	Propor. of roots 13- to 21-lb classes %
523-5H8	546H3 x 417-1	3-way	171	18.57	18	70	60	17	4	2	86.6
F74-718	Inc. 2718	Inbred	140	18.81	12	62	45	13	5	3	85.0
117H8	US H10B	3-way	152	18.90	20	60	50	17	4	5	82.9
Y640	Inc. Y440	OP	165	19.03	12	64	63	17	5	4	84.2
F66-562H0	562H0 x 562	Inbred	143	19.14	15	51	50	17	4	6	81.1
Y439	Inc. Y339	OP	146	19.19	9	56	55	19	4	3	82.2
523-5B (Sp)	Inc. BRS 417-1	OP	124	19.28	13	52	34	11	6	8	79.8
F70-546H3	562H0 x 546	F_1	168	19.37	16	45	73	25	7	2	79.8
Y440	Inc. 3254	OP	162	19.48	9	62	59	20	8	3	78.9
417 (Ore)	Inc. 813 Ore.	OP	105	19.69	8	36	32	15	9	5	72.4
623-5 (A)	Inc. 523-5A	OP	115	19.70	11	50	27	11	5	11	76.5
464H8	US H7A	3-way	173	19.73	7	60	57	38	9	2	71.7
623-5 (Sp)	Inc. 523-5	OP	113	19.73	9	39	41	10	6	8	78.2
464	Inc. F66-64	OP	146	19.76	2	51	60	25	5	3	77.4
464H2	US H6	3-way	160	19.78	7	45	69	33	5	1	75.6
Y639	Inc. Y439	OP	161	19.80	9	45	68	29	6	4	75.8
Y441	Inc. 3255	OP	144	20.07	3	43	56	34	6	2	70.8
4547H1	MS of NB1 x NB5	F_1	152	20.14	4	40	65	29	12	2	71.7
F66-562	Inc. F61-562	Inbred	148	20.24	18	40	45	25	4	16	69.6
468	US 75	OP	133	20.25	3	38	53	26	11	2	70.7
U913H8	US H9B	3-way	166	20.35	19	50	42	27	11	16	67.5
Y641	Inc. Y441	OP	148	20.47	7	36	56	33	12	4	66.9
F70-413	Inc. C413	OP	149	20.56	7	47	49	20	12	14	69.1
1502H0	MS of NB1	Inbred	164	20.65	4	39	60	45	13	5	61.6
F70-546	Inc. F63-546	Inbred	143	20.86	7	28	53	38	13	5	60.8
1502	NB1	Inbred	151	20.90	2	30	65	36	12	6	64.2
F67-563	Inc. F63-563	Inbred	113	21.33	6	25	29	26	14	12	54.0
4554	NB4	Inbred	151	21.42	--	25	59	45	17	5	55.6
4554H1	MS of NB1 x NB4	F_1	153	21.56	3	32	41	45	25	7	49.7
F67-563H0	563H0 x 563	Inbred	141	22.34	9	29	27	30	18	28	46.1
4547	NB5	Inbred	163	22.71	2	15	50	46	34	16	41.1
Mean			147.2	20.12	8.7	44.0	51.4	26.5	9.9	6.7	
LSD .05 = $1.96\sqrt{\frac{2(10.8)}{147.2}}$			--	0.75							
F value between varieties				13.96**							
F value within varieties				3.64**							

Table 2: Evaluation of root toughness vs. plant age and root diameter in 1977

Variety	Seeding Date	Plant Age (wks)	Root Toughness (RT) Mean Probe Value (lbs)1/	Root Toughness (RT) Std. Dev. (s)	Root Diameter (RD) Inches	Root Diameter (RD) Std. Dev. (s)
US H10B	11/18/76	42	22.46a2/	3.94	4.46ab	0.94
US H10B	1/19/77	35	19.71c	3.11	4.60a	0.84
US H10B	3/22/77	27	20.58b	2.21	4.62a	0.83
MonoHy D2	3/22/77	27	19.68c	2.15	4.25b	0.70
US H10B	5/5/77	20	20.96b	3.44	4.41ab	0.74
Mean			20.68	3.21	4.47	0.82
LSD .01			0.77		0.21	
CV (%)			14.7		18.2	
RT x RD interaction = NS						

1/ Based on probe readings of 200 roots for each seeding date.
2/ Means followed by same letter are not significantly different--Duncan's Multiple Range Test.

Yield Compensation in Sugarbeet Infected with Different Strains and Levels of Curly Top Virus

I. O. Skoyen and J. E. Duffus

This study of yield compensation in sugarbeet infected with different levels and strains of beet curly top virus (BCTV) is similar to the study reported in 1976 ("Sugarbeet Research" - 1976 Report, pages A75-A79). The main objective was to determine the compensation on yield by healthy plants growing among diseased neighbors and because of the compensatory effect, what level of BCTV could be tolerated without causing serious reductions in yield. Also, the effects on yield of a mild strain was compared with that of a severe strain of BCTV.

Materials and Methods--The sugarbeet cultivar US H10B, which possesses moderately good resistance to curly top, was seeded May 5, 1977, in a split-split-plot design with 5 replications at the U.S. Agricultural Research Station, Salinas, California. The main plots were two dates of inoculation, June 15 (early) and June 30, 1977 (late), six weeks and eight weeks after seeding. Subplots were two different isolates (strains) of BCT virus. The sub-sub-plots were five levels of BCTV inoculation--16.7, 33.3, 66.7, 100.0% and an uninoculated control treatment. Main plots were randomized within blocks, subplots within main plots and sub-sub-plots within subplots. Plants to be inoculated were evenly and randomly assigned among sub-sub-plot rows. Sub-sub-plot size was five rows, 13 feet long. Stands were thinned to 60 plants per plot prior to the first inoculation.

The two strains of BCTV used for the inoculations included a mild isolate (Strain 11) which was considered a severe strain when it was collected about 25 years ago, and a severe isolate (Logan) collected from Utah, as virulent an isolate as any tested in California.

Inoculations were made by attaching two small leaf cages containing three leafhoppers reared on virus infected plants to the youngest leaves of the plants. The cages were made from 25mm diameter acrylic tubing covered at each end by nylon material and held tight to the leaf surface with bent hair clips. Cages remained on the inoculated plants for 1 week. Insect survival was over 90% during these inoculation periods. The plants were examined at weekly intervals for curly top symptoms until harvest, October 19, 1977, when the plants were 24 weeks old.

Results--Percent infection--As in previous experiments (Sugarbeet Research Report - 1970, 1973, 1975, and 1976), the inoculation technique used resulted in high curly top virus infection under field conditions (Table 1). In the 1977 test, the inoculation of young plants resulted in an average percent infection of inoculated plants with visible symptoms, as shown below:

Inoculation date	Weeks after seeding	BCT Virus Mild strain	BCT Virus Severe strain
EARLY June 15	6	87	97
LATE June 30	8	51	90

The 1977 data did not show, for the late inoculation date, the increase of resistance to infection as the plants increase in size and/or age to the degree it was observed in previous tests with a severe strain of BCTV. This suggests that the environment also influences the development of resistance to infection.

Root yield--The tolerance of US H10B to a mild strain of BCTV was demonstrated in this test (Table 1). Only the early 100% inoculation treatment had significantly lower root yield than that of the control. The reduction was 8 percent. By comparison, the severe strain of BCTV caused significant yield reductions of 7, 27, and 66% for the early 33.3, 66.7, and 100% inoculation treatments. For the late 33.3, 66.7, and 100% inoculation treatments with the severe strain, yield reductions were 7, 11, and 19%, respectively. These were also significant.

The percentage diseased plants in various proportions contributed to total yield for both BCTV strains and for both inoculation dates is shown in Table 2. The differential effect on root yield with infection of young plants by BCTV strains of differing virulence is clearly evident. For the early 66.7% inoculation treatment with the severe strain infected plants contributed 27% to the total yield of 23.7 tons/acre whereas the contribution was 48% to the total yield of 32.7 tons/acre for the mild strain. Healthy plants, through compensation, accounted for 96, 88, and 83% of the root yield for the early 16.7, 33.3, and 66.7% CT treatments, respectively for the severe strain of BCTV. Yield of healthy plants (no visible symptoms) for the late inoculation with the severe strain contributed 89, 77, 49, and 14% to total yield for the 16.7, 33.3, 66.7, and 100% treatments.

A comparison of the average root weight of healthy vs. BCTV infected plants (Table 2) shows that as the number of diseased plants increased, root weight of healthy plants increased in compensation for diseased neighbors, particularly for the early inoculation with the severe strain of BCTV. Comparison of the mean root weights over inoculation treatments shows that for the mild strain, root weight of infected plants was 74 and 93% of the root weight of healthy plants for the respective early and late inoculation

treatments. However, for the severe strain, mean root weight of infected plants was 24 and 67% of healthy plants, respectively, for the early and late inoculation treatments. As has been previously observed, diseased plants tended to have higher average root weights as % CT increased indicating that better growth occurred when they competed with fewer healthy plants.

Sucrose--There were no significant differences in sucrose percentage for BCTV strains, dates of inoculation, or the percent inoculation treatments. This is a departure from earlier test results where significant sucrose percentage losses occurred in the higher percent inoculation treatments of the youngest plants. In 1977, the earliest inoculation treatments were made six weeks after seeding, whereas in previous tests the earliest inoculations were made about four weeks after seeding. The absence of significant effects on sucrose content in 1977 probably was caused by a combination of older and larger sized plants when inoculated and more favorable environmental effects on infected plants than occurred in previous tests.

Separate sucrose percentage determinations were made for the healthy (no visible symptoms) and diseased proportions for each inoculated plot and a weighted average sucrose percentage calculated for use in data analyses.

Gross sugar--The effect of BCTV on gross sugar, particularly that of the severe strain, is shown in Table 1. For the 1977 test the gross sugar values reflect only the effect BCTV had on root yield since there was no effect on sucrose percentage for the various treatments.

Incubation period--The earliest symptoms and maximum expression of BCTV symptoms in the shortest time occurred with the severe strain for both early and late inoculations (Table 1). For the mild strain, the mean weeks to maximum symptom expression was the same for both early and late inoculation treatments; however, the earliest symptoms developed two weeks later for late inoculation than that for early inoculation. The trend in 1977 for symptom expression to be delayed and a longer time for maximum symptom expression (number of infected plants per plot) with later inoculation has also been previously observed. The increasing incubation period for later inoculation dates is an important attribute of BCTV resistance and the minimizing of damage from infection.

Discussion--There are two important phases to the problem of BCTV incidence in sugarbeets: 1) the age at which plants become infected, and 2) the virulence of the strain(s) with which infection occurs. With a virulent strain, such as the severe strain used in the 1977 test, prevention of severe BCTV infection for about the first 8 weeks after seeding would be important to reducing yield losses in areas where the disease is prevalent. The BCTV resistance of present day varieties can tolerate a high incidence of a mild strain of curly top, 67% in the 1977 test, without significant yield loss. However, present day virus strains are generally more virulent than those of 20-25 years ago, so prevention of BCTV infection in sugarbeets must be based on the assumption that infection, if it occurs, will be with BCTV strains capable of damaging currently grown resistant varieties. Both the 1976 and 1977 tests demonstrated that resistant varieties, such as US H10B, can tolerate 20-25% early infection with a severe BCTV strain, without serious losses in yield, because growth of healthy plants compensates for diseased neighbors.

An important factor that has emerged from results of tests in 1975, 1976, and 1977 is that there appears to be little or no damage from BCTV infection until after visible curly top symptoms have developed.

Table 1. Effects of a mild and a severe isolate of the beet curly top virus on a resistant sugarbeet cultivar inoculated with different percentages of virus and at different intervals after seeding.

Date (D) Inoculated	BCTV strain (S)	Percent BCTV Inoculation (I) 0	16.7	33.3	66.7	100	Mean
		Observed BCTV Inf. (%)					
Early (6/15/77)	Mild	0.7	15.1	27.4	56.1	90.6	
	Severe	1.0	16.3	32.4	64.8	97.3	
Late (6/30/77)	Mild	1.0	9.7	16.4	30.0	51.5	
	Severe	1.7	14.1	30.3	61.5	92.2	
		Root Yield (tons/acre)					
Early	Mild	33.2	33.9	33.2	32.6	30.6	32.7
	Severe	32.6	32.0	30.3	23.7	11.2	26.0
Late	Mild	32.0	32.0	31.5	30.9	33.2	31.9
	Severe	33.5	31.2	30.8	30.0	27.3	30.6
		Sucrose (%)					
Early	Mild	12.78	12.80	12.76	12.62	13.01	12.79
	Severe	13.08	12.71	12.78	12.40	13.00	12.79
Late	Mild	13.22	13.55	13.52	13.20	13.09	13.32
	Severe	12.80	13.07	13.20	12.95	13.56	13.12
		Gross Sugar (lbs./acre)					
Early	Mild	8,461	8,643	8,471	8,186	7,949	8,342
	Severe	8,506	8,097	7,748	5,832	2,892	6,615
Late	Mild	8,450	8,597	8,492	8,124	8,655	8,464
	Severe	8,577	8,128	8,118	7,746	7,406	7,995
		Weeks After Inoculation To Maximum Number Plants Showing Symptoms					
Early	Mild	--	9.4	10.0	10.6	11.0	10.3
	Severe	--	6.4	8.4	7.2	8.8	7.7
Late	Mild	--	8.6	10.8	11.0	10.6	10.3
	Severe	--	8.8	9.2	9.0	9.8	9.2
		Weeks To Earliest Symptoms					
Early	Mild	--	3.6	2.4	2.6	2.4	2.8
	Severe	--	2.0	2.0	2.0	2.0	2.0
Late	Mild	--	4.2	5.0	5.0	5.0	4.8
	Severe	--	3.8	3.0	3.6	3.4	3.5

	Roots T/A	Sucrose %	Gross Sugar Lbs.	Maximum Symptom Weeks	Weeks to Earliest Symptom
LSD 5% for Inoc. date (D) means	0.70	NS	355	NS	0.44
for CT Strain (S) means	0.75	NS	283	0.44	0.45
for D x S means	1.06	NS	400	0.62	NS
for % Inoculation(I) means	1.01	NS	292	0.81	0.37
for D x I means	1.43	NS	413	NS	0.52
for I x S means	1.43	NS	413	1.15	0.52
for D x I x S means	2.02	NS	584	NS	0.73

Table 2. Comparison of healthy vs BCTV infected plants for proportionate acre yield and average root weights of a resistant sugarbeet cultivar inoculated at different percentages and intervals after seeding with a mild and a severe isolate of beet curly top virus.

Date Inoculated	BCTV Strain	Percent BCTV 0	16.7	33.3	66.7	100
		Root Yield (tons/acre)				
Early 6/15/77	Mild					
Healthy		33.2	29.9	26.2	17.1	4.2
Infected		--	4.0	7.0	15.6	26.4
Total		33.2	33.9	33.2	32.7	30.6
Cont. of inf. as a % of Total Yield		0	11.8	21.1	47.7	86.3
Late 6/30/77	Mild					
Healthy		32.0	29.2	26.6	22.0	16.7
Infected		--	2.8	4.9	8.9	16.5
Total		32.0	32.0	31.5	30.9	33.2
Cont. of inf. as a % of Total Yield		0	8.8	15.6	28.8	49.7
Early	Severe					
Healthy		32.6	30.6	26.9	17.2	--
Infected		--	1.4	3.5	6.5	11.2
Total		32.6	32.0	30.4	23.7	11.2
Cont. of inf. as a % of Total Yield		0	4.3	11.5	27.4	100
Late	Severe					
Healthy		33.5	27.8	23.8	14.8	3.7
Infected		--	3.4	6.9	15.2	23.6
Total		33.5	31.2	30.7	30.0	27.3
Cont. of inf. as a % of Total Yield		0	10.9	22.5	50.7	86.4

	Tons Roots/Acre Healthy	Infected
LSD 5% for Inoc. date (D)	0.77	0.63
for CT Strain (S)	0.61	0.57
for D x S	0.87	0.80
for % Inoculation (I)	1.20	1.08
for D x I	1.69	NS
for I x S	1.69	1.53
for D x I x S	2.39	2.16

Table 2. (Continued)

Date Inoculated	BCTV Strain	Percent BCTV 0	16.7	33.3	66.7	100	Mean
		Average Single Root Weight (lbs.)					
Early	Mild						
Healthy		4.28	4.60	4.67	5.08	4.74	4.67
Infected		--	3.44	3.32	3.58	3.78	3.53
Inf. root wt. as a % of healthy weight		--	74.8	71.1	70.5	79.7	74.0
Late	Mild						
Healthy		4.13	4.24	4.23	4.15	4.54	4.26
Infected		--	3.84	3.96	3.91	4.17	3.97
Inf. root wt. as a % of healthy weight		--	90.6	93.6	94.2	91.9	92.6
Early	Severe						
Healthy		4.21	4.78	5.15	6.46	--	5.15
Infected		--	1.16	1.41	1.32	1.47	1.34
Inf. root wt. as a % of healthy weight		--	24.3	27.4	20.4	--	24.0
Late	Severe						
Healthy		4.38	4.20	4.44	4.99	5.34	4.67
Infected		--	3.13	2.97	3.19	3.33	3.16
Inf. root wt. as a % of healthy weight		--	74.5	66.9	63.9	62.3	66.9

	Average Root Weight Healthy	Infected	Wt/root (plot total)
LSD 5% for of Inoc. date (D)	NS	0.16	0.63
for CT Strain (S)	NS	0.14	0.12
for D x S	NS	0.20	0.17
for % Inoculation (I)	0.50	0.21	0.13
for D x I	0.71	0.29	0.19
for I x S	0.71	0.29	0.19
for D x I x S	1.00	0.41	0.27

SUGARBEET RESEARCH

1977 Report

Section B

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CONTENTS

I. EXPERIMENTAL FIELD TRIALS

J. C. Theurer and D. L. Doney

A. Agronomic Data

Soil Types: North Farm - silty loam
Farmington Farm - sandy loam

Fertilizer: North Farm - 500 lbs/acre of 16-20-0

Planting Dates: North Farm - May 5
Farmington Farm - April 26

Thinning Dates: North Farm - June 13-15
Farmington Farm - June 1-3

Irrigations: Sprinkler irrigated at both farms until two weeks prior to harvest.

Harvest Dates: North Farm - October 25-26
Farmington Farm - October 11-12

Harvesting Procedures: Tops were removed by beating twice with a rotobeater then topped and dug with a two-row harvester. Beets/plot were counted as they went into a weighing basket on the harvester. Two 10-beet samples were taken at random from each 2-row plot for sugar analysis. All beets in each plot were weighed to determine root yield.

COMMERCIAL AND EXPERIMENTAL VARIETY TEST

J. C. Theurer and D. L. Doney

Six of the current major commercial hybrids grown in the United States and several other experimental varieties were grown at Logan and Farmington, Utah, in 1977. Each entry was planted in six replicates of 2-row plots 38 feet long with plants thinned to approximately 1 foot apart in the row. Sugar percentage, root weight, and quality factors for these varieties are listed in Table 1 for the Logan Test and in Table 2 for the Farmington field trial. Significant differences were observed for all characters measured at each location. Our experimental variety (L29xL21)xL19 had significantly the highest sugar percentage at both locations. UI8, GWD2, and our experimental (L33xL29)x(L5xL37) were consistently high in root yield at the two locations. There was a significant difference between varieties at the two locations. This, no doubt, was due to disease factors. The Farmington Test was infected with fusarium root rot in the spring, which decreased stands differentially for the varieties. In addition, the Farmington plots were severely infected with curly top and also powdery mildew during the last month of the growing season. Lines that were susceptible to these disease factors, particularly curly top, yielded more at Logan where there was little effect from the disease. L53xgl, an F_1 hybrid between inbred L53 and a selection for high hypocotyl diameter, was not significantly different in tons of beets from the highest yielding variety at either location. However, its performance at Farmington was greatly affected by fusarium rot and curly top.

Table 1. Root yield, sugar percentage, and quality factors for commercial and experimental hybrids at Logan, Utah, 1977.

	Acre Yield			PPM			
Description	Gross Sugar (Lbs)	Tons Beets	% Sugar	N	K	Na	Index
UI8	8113	26.21	15.52	553	1327	116	598
GWD2	8089	26.05	15.52	567	1664	68	648
(L33xL19)x(L5xL37)	7755	25.41	15.26	693	1564	76	728
GW Cx2	7697	26.05	14.77	685	1845	106	806
ACS-75-129	7528	23.55	15.98	622	1658	133	680
(L29xL21)xL19	7541	22.67	16.63	574	1483	93	588
L53xgl	7477	25.23	14.83	625	1716	173	752
Hilleshog Nomo	7453	25.33	14.72	563	1912	176	751
HH22	7182	24.80	14.48	601	1864	81	757
GW Cx1	7163	24.51	14.62	660	1831	75	785
USH20	6967	23.23	14.97	635	1556	132	716
GWC3	6912	22.99	15.05	670	1816	70	764
ACS-ACH-107	6821	21.73	15.67	633	1508	165	682
High Sugar Ck.	6740	21.25	15.84	549	1487	120	610
AH10	6633	22.43	14.79	611	1731	92	728
AH11	6621	22.99	14.41	526	1752	96	694
USH10B	6441	23.04	13.99	581	1779	117	763
US22/3	6276	20.80	15.09	609	1527	135	688
Mean	7189	23.79	15.12	609	1668	113	708
F Ratio	5.39**	5.58**	9.62**	2.46**	3.70**	6.29**	4.07**
LSD (5% point)	655	2.02	0.57	86	238	39	89
CV	8.0%	7.4%	3.4%	12.5%	12.5%	30.0%	11.0%

** - Significant at p = 0.01

Table 2. Root yield, sugar percentage, and quality factors for commercial and experimental hybrids at Farmington, Utah, 1977.

	Acre Yield			PPM			
Description	Gross Sugar (Lbs)	Tons Beets	% Sugar	N	K	Na	Index
GW Cx1	8647	26.21	16.52	407	1489	170	509
(L33xL29)x(L5xL37)	8407	23.35	17.80	357	1352	150	418
USH20	8376	26.26	16.01	365	1139	458	512
GWD2	8361	25.23	16.57	412	1450	231	516
UI8	8304	25.47	16.33	369	1362	300	499
USH10B	8192	25.58	16.00	374	1591	292	501
GW Cx2	8119	25.10	16.17	445	1579	226	568
AH11	8000	25.73	15.53	296	1485	270	494
AH10	7991	24.82	16.09	326	1425	300	491
High Sugar Ck.	7923	22.30	17.79	294	1064	238	366
HH22	7744	24.51	15.83	275	1647	195	479
L53xg1	7581	23.77	15.93	340	1325	378	507
GWC3	7431	22.52	16.49	329	1568	180	477
(L29xL21)xL19	7266	20.63	17.64	388	1266	243	449
US22/3	5913	18.36	16.17	396	1406	383	551
ACS-ACH-107	5088	15.70	16.25	332	1185	331	458
Mean	7709	23.47	16.46	357	1396	272	490
F Ratio	5.53**	6.43**	6.24**	1.51*	6.27**	7.60**	2.39**
LSD (5% point)	1133	3.30	0.82	107	189	86	94
CV	12.9%	12.3%	4.4%	26.3%	11.9%	27.9%	16.7%

** - Significant at p = 0.01

II. SEEDLING PHYSIOLOGY

Devon L. Doney

The objectives of the seedling physiology studies are to: 1) gain a better understanding of the seedling growth processes; 2) isolate seedling parameters that contribute to, or are related to, harvest yield and sugar production; and 3) develop these parameters into useful breeding tools. Reported herein is the research progress in five of these studies conducted this past year.

1. Hypocotyl (seedling root) Diameter

a. Combining Ability - In the initial studies of this character the hypocotyl was measured so as not to disturb the growing plant. In later studies, it was found that more accurate measurements could be made by pulling the plant and measuring the area of greatest expansion of the hypocotyl-root organ. All our studies at present are based on the measurement of the area of greatest expansion; hence the name "seedling root diameter."

In earlier reports, we reported a correlation between seedling root diameter and harvest root yield as well as the potential for increasing root yield by measuring the seedling root diameter. Last year we developed a recurrent selection program using this technique as a selection criterion for root weight. This past summer tests were conducted in the field in an attempt to determine the effectiveness of one cycle (one year) in improving yield combining ability. The method of developing the testing populations is described in Figure 1. Seed of the new population (gl) selected for large hypocotyl combining ability was crossed to the same cms tester as the parent population (fl) (Figure 1). The difference between these two crosses should indicate the progress achieved by one cycle of recurrent selection. The parent and new open-pollinated populations were also tested in the field.

The results of these field tests are presented in Table 1. The data are presented in percent of the parent so that the hypocotyl diameter data and the field data can be compared. The predicted yield is the mean hypocotyl diameter of the selections in relation to the total population mean. If the heritability is high (>0.9) and equal amounts of seed were obtained from each selection (to eliminate random draft), the new selection populations should give a 7 percent increase in combining ability; i.e., cms tester x gl should yield 7 percent greater than cms tester x fl. Since the heritability for yield is somewhat less than 0.9, we would expect the actual increase to be less than 7 percent.

Of the 25 selections, eight of the best died before setting seed. The remaining 17 selections gave a mean of 7 percent greater than the parent. The new populations were tested in the greenhouse prior to field testing. In these tests, the testcross of the new population significantly exceeded the testcross of the parent by 5 percent (Table 1).

The field data were not as good. The yield of the testcross of the new population was 2 percent greater than the testcross of the parent; however, this was non-significant (Table 1).

The field results of the open-pollinated populations were much more encouraging. The hypocotyl data for the new population (gl) was 11 percent greater than the parent population (fl) and exceeded the parent by 10 percent in field yield. There was, however, a corresponding 5 percent decrease in percent sugar (Table 1). These differences were both highly significant. The differences for the impurity factors were non-significant. These data strongly suggest that progress can be made for yield, using the seedling diameter (Hypocotyl) as a selection tool. However, a means of selection for sugar percentage must be incorporated into the breeding program to prevent a reduction in the sugar concentration. A method is being developed to incorporate both techniques into a breeding program.

b. Field Test Verification

In greenhouse measurements to verify two 1976 field tests, some apparent misclassifications occurred by the use of hypocotyl diameter technique. These misclassifications were placed into two groups: 1) lines that yielded high in 1976 but gave low hypocotyl diameter readings and 2) lines that yielded low in 1976 and had high hypocotyl diameter readings. Our purpose was to re-test these in the field to determine if genotypes with peculiar growth patterns resulted in a misclassification when measuring the seedling root diameter. Considerable difficulty was encountered in obtaining lines with sufficient seed and germination for field testing. This reduced the number of lines for testing and also reduced the difference (5 percent, Table 2) between the two groups.

The data from this test is given in Table 2. The 1977 field test was similar to the hypocotyl diameter test; i.e., the "low-field, high-hypocotyl diameter" group exceeded the other group by 3 percent for both tests (Table 2). This tends to suggest that the 1976 field test was incorrect. However, these differences were not significant. The impurity factors were all significantly higher and the percent sugar significantly lower in the "low-field, high-hypocotyl diameter" group. These differences may be the result of poor stands.

c. Hypocotyl Diameter Root Yield Correlations

During the past year, we conducted a number of tests from several sources in a continuing effort to establish the relationship between hypocotyl diameter and root yield. These correlations are shown in Table 3. Two of the six tests measured this past year gave non-significant correlations (Table 3). The remaining gave highly significant positive correlations (Table 3). In order to avoid any bias, tests were conducted without prior knowledge of their yield performance.

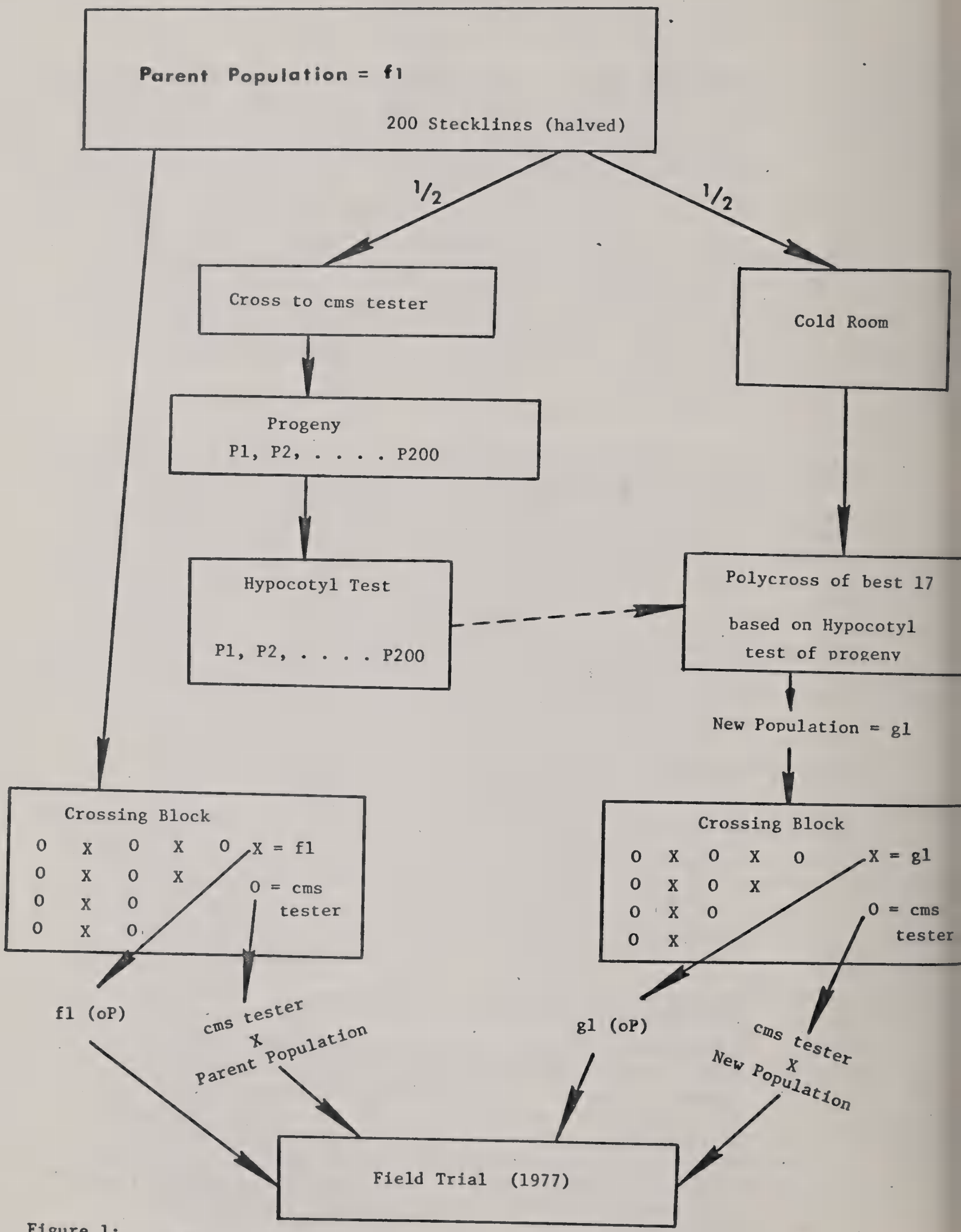

Figure 1:

Flow diagram of recurrent selection for large hypocotyl diameter and development of crosses to test for progress.

Table 1. Percent of parent (f1) of new population with new selected population (gl) for predicted yield, hypocotyl diameter, field root yield, percent sugar, gross sugar, and impurity factors.

	Hypocotyl Diameter		Field Data						
	Predicted Yield	New Population	Root Yield	% Sugar	Gross Sugar	N	K	Na	Index
CMS Tester x f1	100	100	100	100	100	100	100	100	100
CMS Tester x gl	107	105	102	99	101	104	99	95	102
LSD 0.05	5	4	6	3	7	13	10	18	12
f1 (op)		100	100	100	100	100	100	100	100
gl (op)		111	110	95	104	104	103	95	109
LSD 0.05		4	6	3	7	13	10	18	12

Table 2. Field data and hypocotyl diameter data for: 1) high-field, low-hypocotyl diameter and 2) low-field, high-hypocotyl diameter lines.

	High Field Low Hyp. Dia.	Low Field High Hyp. Dia.	LSD 0.05
Yield as % of High field, Low HD			
1976 Field	100	95	6
Hyp. Dia.	100	103	3
1977 Field	100	103	6
1977 Field Data			
Root Yield (T/A)	23.92	24.65	1.53
% Sugar	14.96	13.49	0.47
Gross Sugar (Lbs/A	7156	6687	448
Nitrogen (PPM)	571	647	62
Potassium (PPM)	2114	2769	169
Sodium (PPM)	202	222	26
Index	784	1055	74

Table 3. Correlations between root yield and hypocotyl diameter. Hypocotyl diameter tests made in 1977.

Correlations (r)	Entries	Source or Type
0.78	7	American Crystal (commercial hybrids)
-0.70	7	American Crystal (sugar selections)
0.60	25	TASCO (Variety trial)
0.74	9	USDA (sugar selections)
0.04	7	GW (hybrids)
0.91	11	USDA (sugar selections)

2. Growth of Excised Root Tip

A general observation is that the most vigorous seedlings remain the most vigorous throughout the growing season and give the largest harvest yield. There are also other positive aspects of having early seedling vigor.

One of our methods of trying to measure early seedling vigor is the growth of excised root tips. The approach is to eliminate the seed quality effect and determine the respective genotypic effects by excising the root tips from germinating seedlings, plating them on a growth media, and measuring their growth under controlled conditions.

This technique is rather inexpensive, rapid, and allows for many genotypes to be evaluated at the same time. Root tips are excised from germinating seed three days after being planted in vermiculate. About 1cm of root tip is plated from each seed. Growth is measured at 24-48- and 72-hour periods.

Table 4 gives the data from two tests involving the same hybrids. The relative ranking of the two tests were similar; i.e., GWD2 grew the fastest and 81209 grew the slowest (Table 4). These two hybrids are also the best (GWD2) and poorest (81209) of this group in seedling vigor. The relationship of the remaining six do not fit so well. The rate of growth was most rapid the first 24 hours and decreased in rate with time (Table 4). Another test was conducted to evaluate the effect of seed quality on the growth of excised root tips. One lot of seed was aged for 24 hours at 40C and compared with non-aged seed. The aged seed grew slightly slower the first 24 hours but grew at the same rate as the non-aged the next 72 hours.

The growth is still not uniform enough to use this technique as a screening method. Currently we are studying the effects of hormones, media, etc. to improve this technique.

Table 4. Growth of excised root tips (in mm) of eight hybrids for 24, 48, and 72 hours.

	Test 1	Test 2		
Hybrids	24 hrs (mm)	24 hrs (mm)	48 hrs (mm)	72 hrs (mm)
GWD2	5.58	6.67	9.19	10.49
USH10B	5.53	6.24	9.10	10.17
AH10	5.18	5.03	7.31	8.61
USH20	5.04	6.44	8.79	9.92
UI8	5.03	5.34	8.13	9.17
US22/3	4.98	6.07	8.47	9.63
8174	4.56	5.85	8.34	9.15
81209	3.22	5.16	7.71	8.98
LSD 0.05	1.33	1.10	1.33	1.23

3. Recovery

Two of the problems in measuring small seedlings are the environmental effects and the small genotypic differences at this stage of growth. Plants growing at different growth rates will show larger differences as they grow older because of the accumulative effect. One way to induce genotypes to manifest their genetic differences is to expose them to severe selection pressure. The more vigorous plants ought to recover from a severe shock more rapidly than less vigorous plants and, thus, widen their genetic differences.

A method we have used to induce a severe shock treatment is to trim the leaves back on 2 to 3 week-old plants. Table 5 gives the results of a test involving five hybrids in which half of the plants had their leaves trimmed at 17 days. The hypocotyl diameters were measured on these two groups at 3, 4, and 5 weeks. The first measurements were made 4 days after the beets were trimmed, and already the effect of trimming is evident. Growth was retarded for about 10 days. Growth of the trimmed and untrimmed plants was about the same rate between the 4th and 5th week, although the trimmed plants were smaller (Table 5). Trimming reduced the CV slightly and seemed to give a little better separation between the hybrids.

Table 5. Hypocotyl diameter of trimmed and untrimmed plants at 3, 4, and 5 weeks of age. All but the smallest leaf was removed from the trimmed plants at 17 days old.

	3 Weeks		4 Weeks		5 Weeks	
Hybrids	Trimmed	Untrimmed	Trimmed	Untrimmed	Trimmed	Untrimmed
GWD2	102.6	114.1	118.5	162.4	153.8	206.2
USH10B	102.5	109.6	113.1	168.9	142.0	195.5
USH20	99.7	110.1	111.8	164.1	148.2	203.9
AH10	95.5	110.7	110.9	162.3	142.8	203.5
UI8	92.0	102.4	105.7	149.2	137.1	170.5
LSD	6.4	7.5	8.2	11.4	10.2	20.3
$\bar{x}$	98.4	109.3	112.1	161.4	144.8	195.7
CV	10.4%	11.0%	11.7%	11.3%	11.2%	16.5%

4. Competition

Another method to induce severe shock is to place plants under extreme competition. We achieved this by planting in 5cm diameter pots. The competing genotype was planted in the center surrounded by four plants of a common competitor check variety. In this case, the common competitor was a very uniform hybrid. This made five plants in each 5cm diameter pot. The competing genotypes tested were GWD2, USH20, and US22/3. In order to obtain a measure of the two competition parameters (competitive ability and competitive influence), each competing genotype was also planted in the same sized pots surrounded by four plants of its own genotype. In this case, it was competing with itself. Plants were harvested at 3 weeks of age and hypocotyl diameters measured. There was a slight increase in the CV when the genotypes competed with the common competition rather than themselves (Table 6). We expected

the CV to be lower with the common competitor. This may reflect more genetic variation in the common competitor than was anticipated. The range between the three competing genotypes was increased, however, and gave significant differences (Table 6). The more vigorous genotype increased, and the less vigorous decreased in size as a result of competition. The competitive ability and the competitive influence were calculated (Table 6). The competitive score (sum of the two parameters) gave a very close approximation of the respective hybrid vigor and hypocotyl diameter under severe competition.

Table 6. Competition parameters of three competing genotypes. Data are hypocotyl diameters of 3-week-old seedlings.

	Competition with				
	Self	Common Competitor	Competitive Ability	Competitive Influence	Competition Score (sum)
GWD2	103.2	114.4	+11.2	-3.5	+7.7
USH20	100.6	108.8	+ 8.2	-7.0	+1.2
US22/3	99.1	89.6	- 9.5	+3.8	-5.7
CV	11.0%	12.9%			
LSD 0.05	8.2	8.2			

5. Osmotic Concentration

Sugarbeet genotypes with higher concentrations of sugar are able to store and retain higher concentrations of osmolites (sugar) within their cells than sugarbeet genotypes of lower sugar percentages. Since these solutes are retained within the cell against a concentration gradient, they have a higher osmotic concentration and exert a higher osmotic pressure. Measurement of the osmotic pressure is, therefore, an indirect measure of sugar concentration.

Since the cells of a young plant are genetically the same as mature plants, they ought to have the same osmotic concentration potential as mature plants. It might also be argued that the reason high nitrogen reduces sugar concentration is because sugar solutes are replaced by nitrate solutes in the cell. Because the osmotic potential is genetically fixed, the plant cannot store as much sugar per cell and, therefore, has a reduced sugar concentration. If this theory is correct, the osmotic pressure of a given genotype will not be affected or changed by differing nitrogen level. Likewise, the osmotic pressure of young plants will be the same as mature plants or their relative ranking will be the same and, therefore, give a measure (ranked) of the sugar concentration potential.

One of the important variables affecting osmotic pressure is available water. When water is limiting the turgor, pressure is reduced, and the osmotic pressure is increased. With increasing amounts of available water, the osmotic pressure is reduced until, at water saturation, the osmotic pressure equals the turgor pressure. Differences in available moisture could give differences in osmotic pressure that are due to available moisture and not genetic. Therefore, in order to measure genetic differences, the plants ought to all be in soil at field capacity so that the cells are at water-saturation.

We had previously tested mature beets at harvest time and obtained a fair relationship between the osmotic pressure and percent sugar. We next tested the osmotic pressure of 3-week-old seedlings. The soil was brought to field capacity 4 hours prior to sampling. One to two cm of root from each plant were frozen. The roots were later unfrozen and squeezed. This expressed juice was tested for osmotic pressure. Two tests were conducted involving field tests. The correlations between osmotic pressure and percent sugar were 0.48* and 0.36. It appeared that the significant correlation was a result of L19 hybrids which gave the highest osmotic pressure and highest percent sugar.

We have also tested the effects of four environmental parameters (fertility level, drought, day length, and temperature) on the osmotic pressure. These parameters and the respective data are listed in Table 7. High fertility tended to decrease the osmotic pressure and increase the root size (Table 7). This tends to refute the theory that the osmotic pressure remains the same regardless of the nitrogen level.

Drought was simulated by adding polyethylene glycol to the nutrient solution. The amount added turned out to be on the low side and only showed slight drought effects. The effect of drought, as expected, was to increase the osmotic pressure and decrease root size (Table 7).

Both day length and temperature had an effect on root size. The effect on osmotic pressure was related to root size; i.e., the larger the root, the larger the osmotic pressure and vice versa (Table 7). Three genotypes differing by about two percentage points in sugar were selected to test at each environmental parameter. There were no significant environmental parameter times genotype interactions; i.e., the rank of the three genotypes were the same regardless of what environmental parameter was imposed. In all tests, L19 (the highest sugar genotype) had a significantly higher osmotic pressure than the other two genotypes (Table 8). The osmotic pressure of genotypes GWD2 and USH10B was very close in every test although they are normally about two percentage points different in sugar. We have noted in other research that genotype L19 has a different physiological mechanism for sugar accumulation than most other genotypes tested. This research suggests that the osmotic pressure of seedlings will not predict the sugar potential for most genotypes; however, it will predict the sugar potential for genotypes possessing the sugar genes found in L19.

This theory was tested by planting a field test of lines that had been selected out of a segregating L19 cross. Each line was tested for its osmotic pressure in the seedling stage. Differences in sugar percentage were not large, but a better relationship was achieved between the seedling osmotic pressure and the percent sugar. The correlation was a significant 0.52. The three high sugar lines and the low sugar line for percent sugar were the same lines, respectively, for seedling osmotic pressure. The ranked correlation was a significant 0.70.

Table 7. Osmotic pressure and hypocotyl diameter for 5-week-old seedlings at different levels of fertility, drought, day length and temperature.

	Osmotic Pressure	Hypocotyl Diameter
Fertility Level		
Low-low	802	.154
High-low	865	.174
Low-high	708	.165
High-high	739	.180
LSD	45	.010
Simulated Drought		
Normal	679	.200
1% PEG	704	.190
2% PEG	717	.188
LSD	68	.012
Day Length		
24 hrs	512	.156
9 hrs	428	.143
LSD	28	.012
Temperature		
24% continuous	824	.189
24° (8 hrs) -5° (16 hrs)	806	.138
LSD	78	.018

Table 8. Osmotic pressure and hypocotyl diameter for 5-week-old seedlings of L19, GWD2, and USH10B.

	Osmotic Pressure	Hypocotyl Diameter
Fertility Level		
L19	830	.141
GWD2	731	.181
USH10B	775	.183
LSD	38	.009
Simulated Drought		
L19	774	.165
GWD2	647	.200
USH10B	677	.213
LSD	68	.012
Day Length		
L19	555	.120
GWD2	456	.150
USH10B	468	.149
LSD	31	.016
Temperature		
L19	939	.130
GWD2	796	.180
USH10B	816	.178
LSD	90	.022

III. GROWTH ANALYSIS

SEASONAL SUGAR ACCUMULATION IN SUGARBEET

J. C. Theurer and D. L. Doney

Data from experiments in 1975 and 1976 demonstrated that sugar accumulates in the root in a linear manner during the entire growth season (1975 Research Report, p. B44, 1976 Research Report p. 43). The rate of accumulation was significantly different for inbreds and for hybrids with different sugar content at harvest. Our observations were contrary to the previous general consensus that sugar has its greatest accumulation in the root during the later part of the growing season when night temperatures are cooler.

This past year we experimented with plant material from diverse sources that had high sugar content at harvest. Four of the eighteen entries studied were inbreds (two high sugar, and two low sugar lines). The balance of the entries were hybrids from United States and European sources. Two of our experimental hybrids known to be low in sugar content and one that had a previous record of high sugar percentage at harvest were included in the test as check varieties. The field plot was a split-split plot of six replications with inbreds and hybrids in subplots and harvest dates as whole plots. Individual entries were each planted in two 22-inch-row plots 20 feet long. Plants were approximately 12 inches apart in the row.

Harvests were made on July 5, August 8, September 12, and October 17. All beets in a ten-foot section of each plot were dug by hand on each date. Root weight, top weight, and sugar content were determined for each sample. For the first harvest, all samples were shredded with a vegetable shredder and macerated in a blender to obtain a brei sample for sugar percent determination. The roots were of sufficient size during the later harvests so that a brei sample could be obtained using the spreckels saw.

The root diameter, number of vascular rings, and the width of the center five rings were determined from a cross sectional slice of five representative beets from each plot for the last three harvests. Amino N, Na, and K content, and an impurity index were determined on samples from the final harvest.

RESULTS

The gross sugar, beet weight, and sugar percent for each harvest are listed in Table 1. Beta 1345, GWE4, and GWD2 demonstrated the most rapid seedling growth as shown in columns 2 and 6 of Table 1. Hybrids 1103, 1107, Beta 1345, GWD2, and AH12 produced the greatest sugar yield for the season. In general, varieties having the greatest yield early in the season were also among those exhibiting the largest yield at final harvest. At the first harvest date, one of the low-sugar hybrid checks and the high-sugar hybrid check variety had equal sugar percentage. HS#2 was highest in sugar percent for all entries for this harvest date. From the second harvest on, the high sugar checks were high, and the low sugar checks were low in sugar percentage. The data confirm previous years studies showing that sugar accumulates in a linear manner during the entire growing season (Figures 1 and 2). This year's data confirm previous years findings that the period of most rapid rate of sugar accumulation is early in the growing season. In this study, it was between the first and

second harvests; July 5 and August 8. There were significant entry X rate interactions for sugar content. Some had a high sugar content at the final harvest due to earlier initial development of a high sucrose percentage, whereas others had a high sugar at harvest due to a greater accumulation rate during the entire growing season. In general, high yield varieties were lower in sucrose at harvest due to both a low initial sugar content and a slower accumulation rate during the growing season.

Root diameter, top weight, and root/top ratio for each harvest are given in Table 2. Highly significant differences were noted for each character that were measured and for each harvest. As expected, root diameter increased throughout the growing season but at different rates. During the period between the first and second harvest dates (July 5 to August 8), the diameter of the roots was doubled. This demonstrates the importance of early seasonal effects on the ultimate yield of the crop. No consistent pattern in the change of root diameter was evident for high sugar vs yield types. For example, the inbreds showed a consistency over harvests; however, the line having the higher sugar content (HSI#1) was no different than low-sugar inbreds (LS#1 or LS#2). The other high-sugar inbred (HSI#2) was significantly smaller in size than either the HSI#1 or LSI Lines. Beta 1345 and 1107 were consistently high in root diameter at each harvest, and 1106 and 1109 were consistently among the hybrids having a small root diameter at each harvest. Root diameter was not correlated with sugar percent but showed a good correlation with root weight (r=0.80) (Table 3).

The top weight growth pattern was similar to that for root diameter and also demonstrated that the most rapid growth rate of the tops was achieved during the period between H_1 and H_2. Top weight was significantly correlated with high root weight during each harvest. The correlation coefficient was better for H_2 than later harvests (Table 3). There was an apparent tendency for the top weight and root weight association to decrease as the length of the growing period increased.

At the time of the first harvest, the roots weighed approximately one-third as much as the tops (Table 2). By H_2, the roots weighed 75 percent that of the tops. The roots of most entries were equal in weight, or slightly heavier than the tops at H_3; and at H_4, the roots averaged 25 percent more weight than their respective tops. Thus, in this study, the tops weight was greater than root weight until September. GWE4 had the largest top/root ratio, and ACH14 the smallest ratio of the hybrids at the first harvest date. Hybrids 1102 and the LS#2 check were high in their root proportion compared with other entries for all harvests. Hybrids 1109 and ACH14 had a lower root proportion over all harvests.

The number of vascular rings in a sample of five representative beets of each hybrid and inbred for H_2, H_3, and H_4 were counted. Although differences were observed in ring number for each harvest, the majority of the hybrids showed a similar number of rings and averaged about nine rings per beet. No consistency for high or low ring numbers was observed between known high sugar vs low sugar inbreds or hybrids. At the second harvest, a significant negative correlation of -0.64** was observed with sucrose percent. However, there was no correlation between these variables at later harvest dates, and no correlation of ring number with root weight (Table 3).

The width of the first five rings from the center of the root was measured for the last three harvests also. Ring widths were quite similar for most varieties at the H_3 and H_4 harvest dates, and they were slightly larger on these harvest dates than the ring widths at the second harvest date. Ring width showed a positive correlation with root weight and a negative association with sugar percentage (Table 3). This suggests that high yielding varieties have vascular rings of greater width than do low yielding varieties. High sugar varieties tend to have narrower ring widths than low sugar varieties. Correlations of ring width were stronger with root weight at the last harvest in October; however, no association with sucrose was evident at the H_4 harvest date.

The Amino N, Na, K, and impurity index values for the last harvest H_4 are listed in Table 4. There were no differences in the entries for Amino N, but significance was observed for the other quality factors and for the impurity index.

CONCLUSIONS

1. In general, varieties having the greatest yield early in the season also exhibited the greatest yield at the final harvest.

2. Sugar accumulates in a linear manner during the entire growing season and not only at the end of the season.

3. The period of most rapid rate of sugar accumulation was during the month of July and the first part of August.

4. The root diameter of most lines was doubled between H_1 and H_2; however, no difference was observed between high sugar and low sugar checks.

5. Root diameter was not correlated with sugar percent but showed a good correlation with root weight.

6. Top weight was associated with root weight at all harvests but showed a decrease in association as the growing period increased.

7. Tops weighed more than roots until September, then exceeded the tops by approximately 25 percent at the final harvest.

8. The width of vascular rings 2, 3, 4, and 5 from the center of the beet showed a significant negative association with sugar percentage and a positive association with root weight.

9. Correlations between width of vascular rings 2, 3, 4, and 5 from the center of the beet suggest a strong association between wide rings and high beet weight and narrow rings and high sugar percentage.

Table 1. Gross sugar, root weight, and sugar percentage for high sugar varieties - Logan, Utah, 1977.

Hybrids	Gross Sugar Lbs				Root Wt. T/A				Sugar %			
	H_1	H_2	H_3	H_4	H_1	H_2	H_3	H_4	H_1	H_2	H_3	H_4
1101	217	3018	6795	7816	1.69	11.9	22.6	24.7	6.43	12.63	15.02	15.72
1102	180	2964	6844	7648	1.31	11.6	22.3	24.5	6.85	12.80	15.35	15.57
1103	252	3042	6855	8877	1.86	11.9	21.7	25.1	6.80	12.77	15.77	17.65
1106	229	3141	6166	7888	1.61	11.3	18.7	22.8	7.10	13.93	16.50	17.32
1107	240	2981	5724	8314	1.97	11.2	19.9	25.2	6.07	13.35	14.30	16.55
1109	217	2814	5889	6976	1.54	10.4	19.2	20.9	7.10	13.48	15.58	16.63
Beta 1345	283	3339	7135	8343	2.07	13.0	23.7	24.7	6.85	12.85	15.10	16.87
GWE4	273	3054	6339	8281	2.12	11.1	20.6	25.1	6.48	13.80	15.45	16.52
GWD2	278	2910	6578	7859	2.09	11.8	22.9	25.6	6.60	12.33	14.37	15.42
AH12	244	3005	6868	8106	1.73	11.3	22.7	24.3	7.15	13.32	15.15	16.68
ACH14	215	2622	5551	7261	1.62	10.1	18.5	21.7	6.80	13.02	14.98	16.68
HS check	266	3188	6238	7806	1.84	11.1	19.8	22.3	7.28	14.33	16.75	17.50
LS #1 "	273	3181	6264	7829	1.97	12.4	21.6	25.1	6.95	12.82	14.53	15.63
LS #2 "	175	2557	5098	7118	1.20	9.8	17.6	23.2	7.30	13.08	14.50	15.33
Inbreds												
HSI #1	119	2021	4837	6096	0.90	6.9	13.6	16.4	6.68	14.72	17.80	18.55
HSI #2	70	1572	3641	4579	0.44	5.5	11.2	14.0	8.05	14.18	16.25	16.38
LSI #2	120	2373	4939	6559	0.89	9.1	16.9	21.1	6.85	13.02	14.58	15.50
LSI #1	108	2340	6081	6632	0.86	9.3	21.5	23.0	6.40	12.60	14.00	14.42
Mean	209	2785	5997	7444	1.54	10.5	19.7	22.8	6.88	13.28	15.28	16.38
LSD 0.05	45	378	937	1182	0.32	1.38	2.80	3.25	0.77	0.83	0.87	1.01
CV	18.8	11.8	13.6	13.8	18.2	11.4	12.3	12.4	9.9	5.4	4.9	5.4
Calc F	16.88**	11.71**	7.34**	5.80**	19.01**	15.01**	11.08**	7.40**	2.48**	5.12**	9.19**	7.81**

Table 2. Root diameter, top weight, and root/top ratio for high sugar varieties - Logan, Utah, 1977.

	Root Diameter cm				Top Weight Kg				Root/Top Ratio			
Hybrids	H_1	H_2	H_3	H_4	H_1	H_2	H_3	H_4	H_1	H_2	H_3	H_4
1101	3.34	7.17	8.17	10.37	3.99	12.10	14.01	14.90	0.32	0.77	1.26	1.27
1102	2.94	7.17	8.50	10.90	2.83	10.91	12.07	13.40	0.33	0.83	1.49	1.42
1103	3.31	7.00	8.17	10.67	4.87	13.17	15.10	14.15	0.29	0.71	1.17	1.22
1106	2.85	6.33	7.17	9.50	4.67	14.00	15.71	14.91	0.27	0.63	0.92	1.19
1107	3.24	7.17	10.00	11.00	4.88	10.97	12.67	14.30	0.31	0.79	1.28	1.37
1109	2.94	6.50	7.33	9.93	3.98	12.62	16.17	16.65	0.29	0.64	0.94	0.97
Beta 1345	3.54	7.17	9.00	11.10	5.10	12.63	14.92	14.38	0.31	0.81	1.24	1.33
GWE4	3.44	6.33	8.33	10.33	4.71	11.48	13.71	15.74	0.35	0.76	1.19	1.23
GWD2	3.05	6.83	10.17	9.97	5.81	13.31	17.09	15.51	0.28	0.69	1.06	1.28
AH12	2.99	6.50	8.00	9.93	4.57	12.16	16.96	14.68	0.29	0.72	1.06	1.30
ACH14	2.98	6.50	10.17	9.37	5.32	13.26	16.76	17.03	0.24	0.61	0.86	0.99
HS Check	3.13	6.50	10.00	9.57	4.77	10.99	12.84	14.15	0.30	0.78	1.20	1.22
LS #1 "	3.49	7.00	8.00	10.17	4.60	10.79	12.12	11.88	0.33	0.91	1.44	1.63
LS #2 "	3.03	7.17	10.83	10.68	2.72	7.27	9.50	13.62	0.34	1.06	1.48	1.32
Inbreds												
HSI #1	2.55	7.00	8.00	9.73	2.64	8.12	11.70	14.45	0.26	0.65	0.90	0.88
HSI #2	1.77	5.00	5.83	7.27	1.17	4.04	5.98	7.79	0.29	1.07	1.50	1.39
LSI #2	2.39	6.17	7.17	9.50	3.04	11.10	12.76	14.30	0.22	0.64	1.05	1.16
LSI #1	2.49	6.33	8.33	10.30	3.24	11.91	18.13	16.42	0.20	0.62	0.94	1.08
Mean	2.97	6.66	8.50	10.02	4.05	11.16	13.79	14.45	0.29	0.76	1.16	1.24
LSD 0.05	0.27	0.73	0.72	0.88	0.83	1.83	2.79	2.07	0.4	0.11	0.20	0.17
CV	7.9	9.5	7.41	7.68	17.9	14.3	17.6	12.5	10.8	12.8	15.2	11.6
Calc. F	21.34**	4.48**	25.58**	7.70**	16.23**	14.36**	9.22**	7.99**	9.81**	12.06**	8.87**	9.37**

Table 3. Correlation coefficients for top weight, root diameter, ring number, and ring width with sugar percentage and root weight - high sugar varieties - Logan, Utah, 1977.

	Sucrose %			Root Weight		
	H_2 1/	H_3	H_4	H_2	H_3	H_4
Top Weight	-.48*	-.27	.04	.76**	.67**	.49*
Root Diameter	-.44	-.43	-.15	.63**	.43	.80**
No. vascular rings	--	-.23	-.09	.33	.11	.14
Width of Ring #1	--	-.23	-.09	--	--	--
" " " #2	-.24	-.67**	-.30	.13	.77**	.74**
" " " #3	-.57*	-.69**	-.32	.62*	.74**	.80**
" " " #4	-.63**	-.42	-.27	.71**	.64**	.79**
" " " #5	-.64**	-.41	-.18	.66**	.71**	.68**

* Significant at 0.05.
** Significant at 0.01.
1/ Harvest H_2=Aug. 8, H_3=Sept. 12, H_4=Oct. 17.

Table 4. Amino N, sodium, potassium, and impurity index values for high sugar varieties - Logan, Utah, 1977.

	PPM			
Hybrids	Amino N	Na	K	Index
1101	558	180	2045	717
1102	577	195	1491	735
1103	505	165	1825	575
1106	589	77	1466	569
1107	656	135	1916	715
1109	391	150	1520	499
Beta 1345	607	161	1866	669
GWE4	569	102	1691	624
GWD2	536	68	1741	649
AH11	576	86	1508	592
ACH14	568	117	1595	607
HS Check	641	112	1437	595
LS #1 "	580	171	1741	689
LS #2 "	606	88	1925	730
Inbreds				
HSI #1	682	107	1583	601
HSI #2	677	136	1262	633
LSI #2	544	171	1766	675
LSI #1	645	106	2170	810
Mean	584.36	129.58	1722.69	649.62
LSD 0.05	151.79	36.64	254.59	121.45
CV	22.6	24.6	12.9	16.3
Calc. F	1.62 NS	8.74**	6.81**	3.05**

MORPHOLOGICAL GROWTH OF INBREDS AND HYBRIDS

J. C. Theurer and D. L. Doney

In 1975 and 1976, experiments were carried out at Logan, Utah, to compare morphological growth factors of inbreds and hybrids of diverse genotype. In 1975, the hybrids reached their maximum leaf size at least a week prior to when the inbreds had their maximum leaf area. In 1976, hybrids and inbreds tended to reach maximum leaf area at the same time of year. We thought differences between the 2 years could be assoicated with fertilizer differences, as the 1976 plots showed fertilizer deficiency symptoms early in the growing season. Thus, we repeated the study in 1977 but with fewer entries in the test.

MATERIALS AND METHODS

Five inbreds and six hybrids of these inbreds were planted May 12, 1977, at the Evans farm near Logan. Plots were single rows 20 feet long with plants carefully thinned with a measuring stick to 15 inches within the row. Six replicates were in the test. Five representative beets in each row were selected for detailed study. The width and length of each leaf on each plant were measured six times during the growing season. The first reading was made on July 11, and the last reading was made just a week prior to harvest on September 12. The four other reading dates were July 25, August 1, September 8, and August 15. These weekly dates spanned the period of time corresponding with the period when the entries in 1975 and 1976 had reached maximum leaf development.

The total number of leaves on each plant and an estimate of leaf area (leaf width x leaf length) were generated from the measured data each harvest date.

RESULTS

Seasonal growth curves for leaf area for the inbreds are shown in Figure 1 and for the hybrids in Figure 2. They were very similar to data collected in previous years. Maximum leaf area for both inbreds and hybrids was reached at approximately the same time as was observed in 1976. Differences between the three years data in the growth curves were probably due to planting date: 1975 = June 17, 1976; June 3 and 1977 = May 12. Data of the 3 years show that it takes 60-70 days growth until the maximum canopy is developed. In our area, this is between July 24 and August 10. Heterosis was observed for leaf area for most hybrids. The midparent value was a good estimate for hybrids with L29 parentage but not for L53 hybrids. C13 and L37, L53xL37, and L53xC13 were the entries having the most rapid leaf accretion.

The number of leaves increased linearly throughout the growing season to the end of August (Figures 3 and 4). The L19 inbred and L19 hybrids tended to show continual leaf accretion throughout the growing period. Other inbreds and hybrids showed a plateau effect. C13 showed a decrease in leaf number, but this may be an artifact.

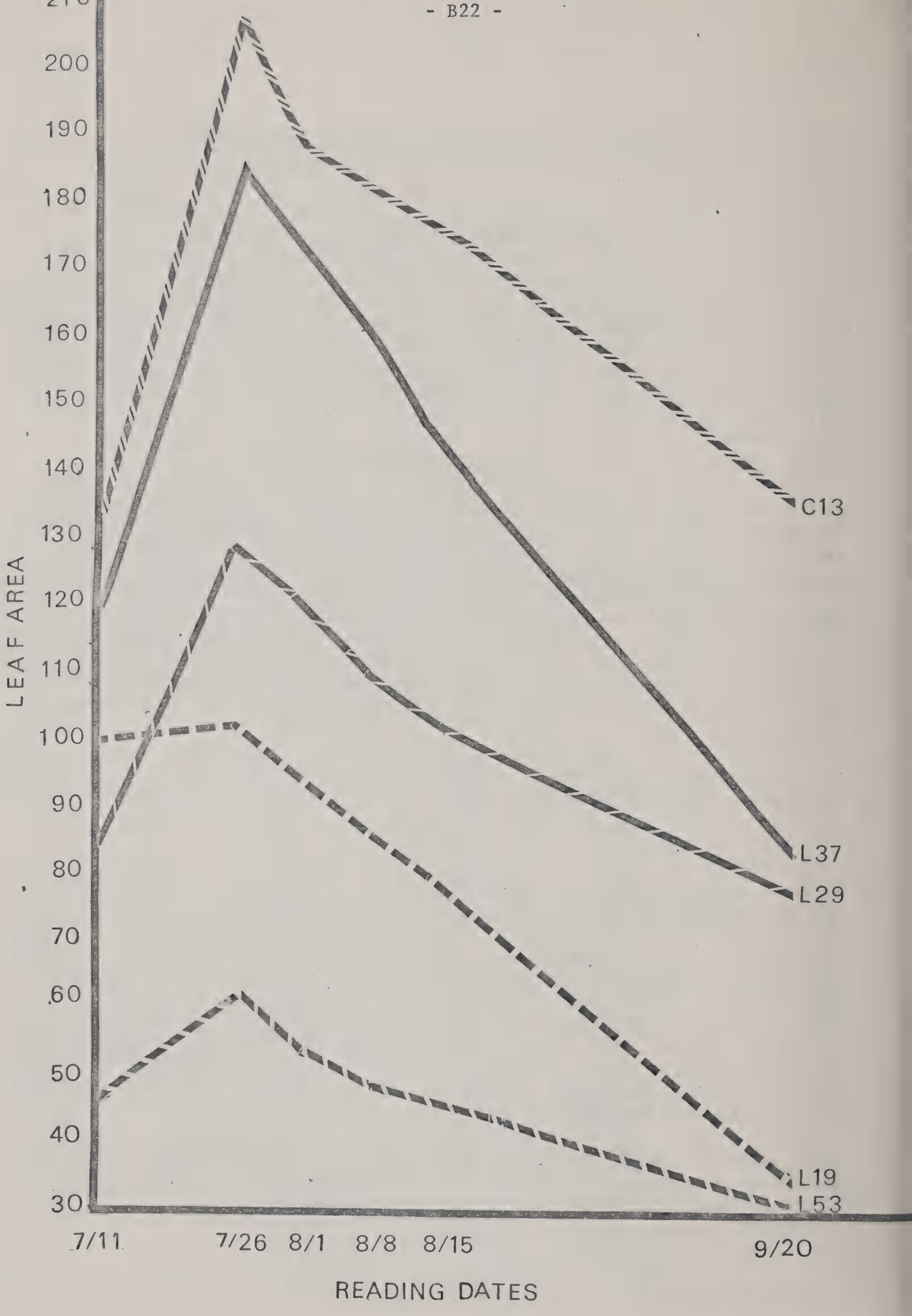

Figure 1. Leaf area of inbreds - 1977

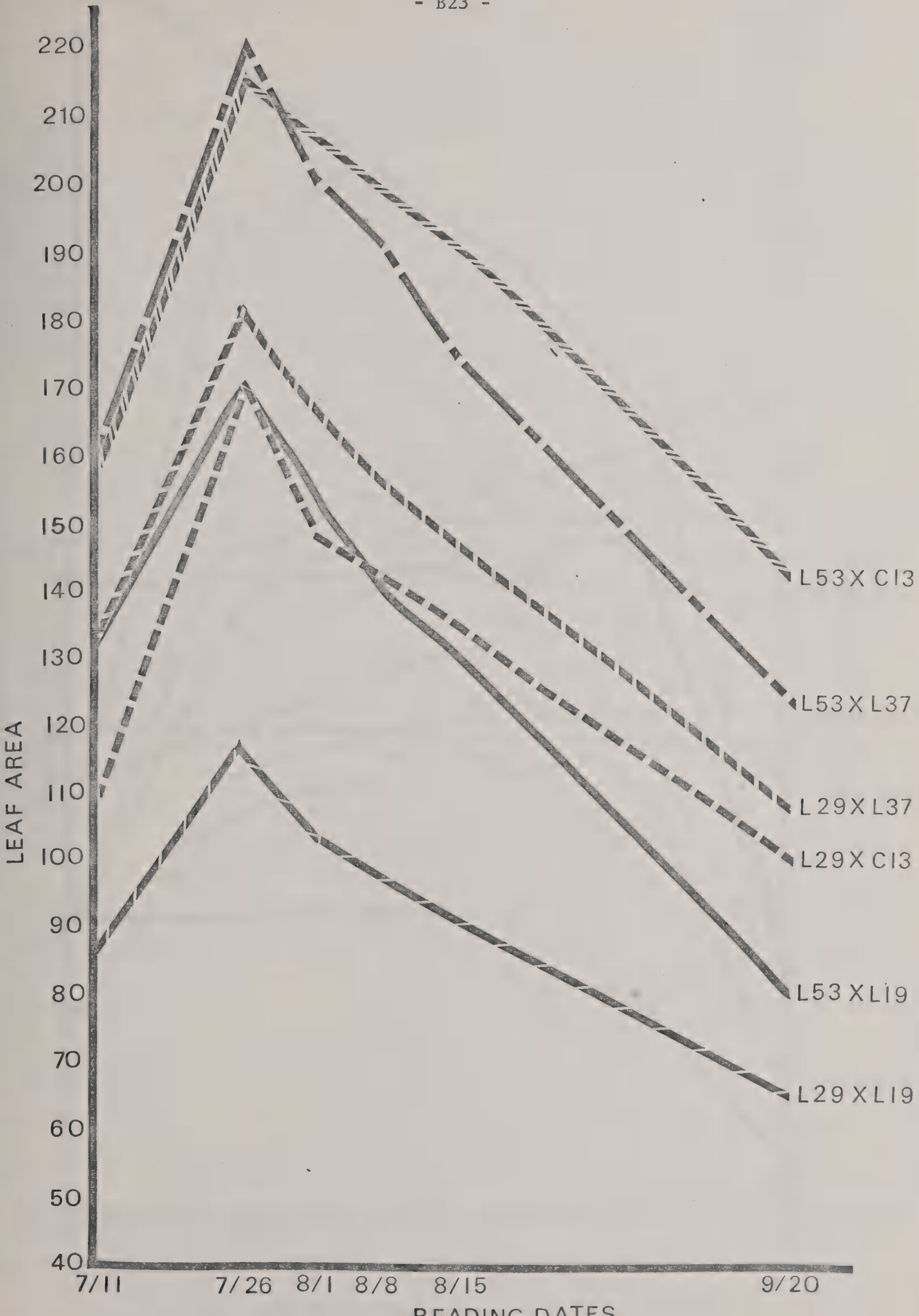

Figure 2. Leaf area of hybrids - 1977.

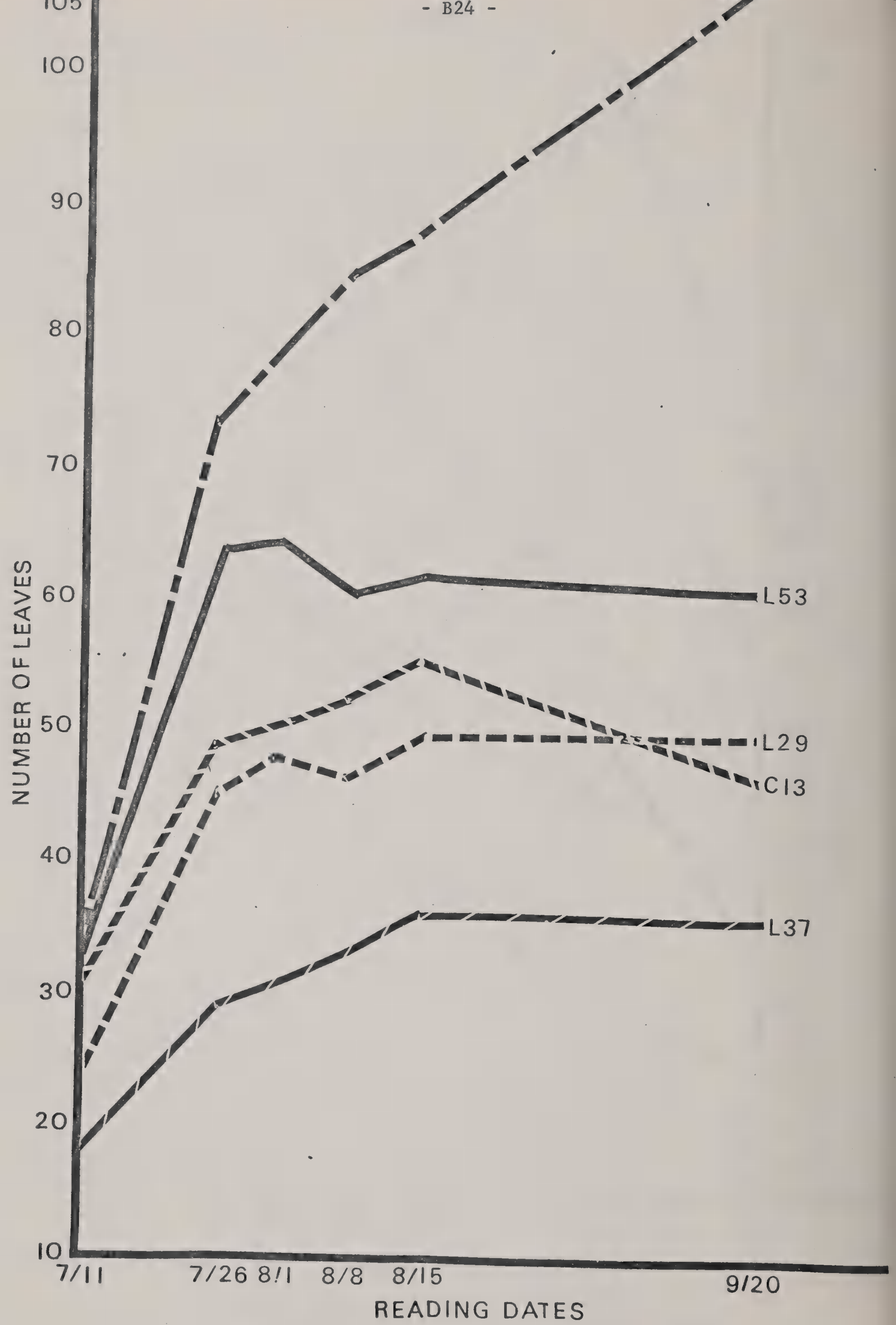

Figure 3 Leaf accretion of inbreds - 1977.

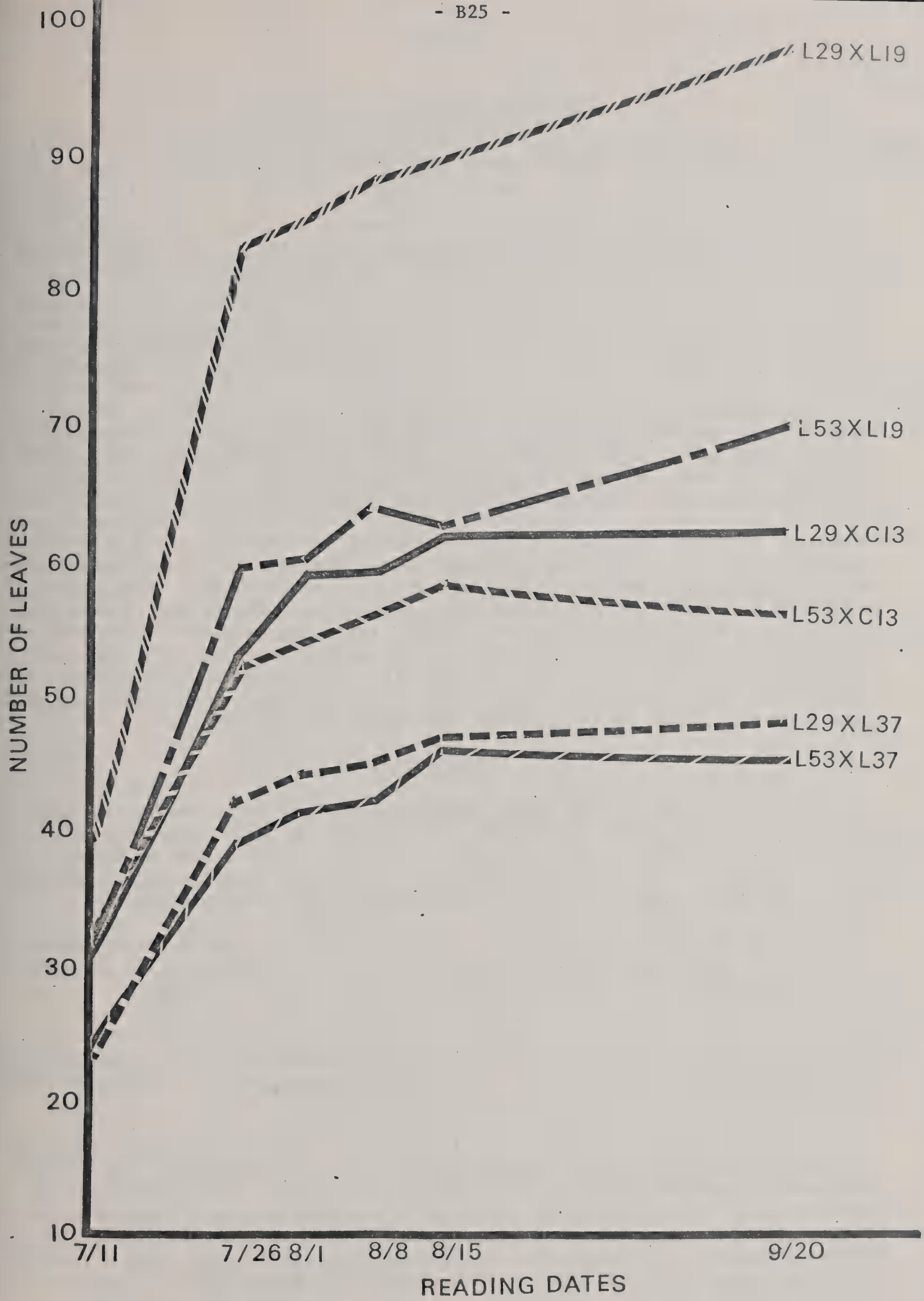

Figure 4. Leaf accretion of hybrids - 1977.

COMPETITIVE EFFECTS OF GENOTYPES UNDER DIFFERENT PLANT DENSITIES

J. C. Theurer and D. L. Doney

It has been suggested that selection can be made during the early growth period of the sugarbeet to obtain varieties that have the ability to produce high yield with good sugar content in close spacings. This experiment was initiated to observe the effect of three plant densities on four varieties.

The field plot consisted of four replications with three spacing blocks in each. One block was marked on a grid 6 x 6 inches, the second 12 x 12 inches, and the third 24 x 24 inches. The individual variety plot in the 6-inch spacing consisted of eight rows 7 feet long with two rows of a uniform variety as a buffer on the outside of each plot and two between each variety. The individual plot for the 12-inch spacing was eight rows 7 feet long with two buffer rows on the outside of the plot and one buffer row between varieties. The plot for the 24-inch spacing also consisted of eight rows 14 feet long and buffered similar to the 12-inch spacing. Seeding was done with a hand planter. Hills were thinned to a single plant at the 4-leaf stage of development, and a near-perfect stand was obtained. At harvest, the beets were dug by hand. The first and last beet of each row in the 12- and 24-inch spacing were discarded. Thus, root weight and top weight were measured on 40 beets from each 12- and 24-inch plot per replicate and 80 beets from each 6-inch plot. All harvested roots were used to obtain a brei sample for determination of sugar percentage. The data were adjusted to equalize the land area between the spacings prior to analysis. Root diameter, number of vascular rings, and width of the first five rings were determined from a slice of the root through the widest part of each beet.

RESULTS

Gross sugar, root weight, and sugar percentage for the varieties at the different plant densities are shown in Table 1. The optimum yield was consistently attained at the 12-inch spacing. Gross sugar for the mangel was the same at 6-inch and 24-inch spacings. The three other varieties exhibited greater tonnage at wide spacing (24-inch) than they did at an increased plant density (6-inch).

The yield of the mangel exceeded all other varieites. We could have expected even greater differences than observed since the curly top incidence in the field affected this variety more than the others.

In general, sugar percentage was lower for varieties grown at the 6-inch spacing than at the other plant densities. However, the mangel proved an exception. For this variety, beets grown at the 24-inch density showed significantly the lowest sugar percentage.

The top weight, root/top ratio, root diameter, and number of vascular rings of beets are listed in Table 2. Considering the overall space means, the 12-inch plant density was the one with the greatest top weight. However, both 53.13 and the mangel variety showed a reduction in top size as competition decreased between adjacent beets. In all cases, the data demonstrate that plants of all varieties under highly competitive conditions (6-12-inch space) have a greater proliferation of tops than plants grown with little plant-to-plant competition.

All varieties showed an increase in root-top ratio as plant density was increased. This also shows the compensating effect of tops under high plant density. As expected, the mangel had the largest roots and smallest tops of the varieties tested.

Root diameter for all varieties increased as plant density decreased. There was no difference, however, among the varieties at any given plant density. Rank correlation between root weight and root diameter = 1 for each plant density. This tends to support our other research work demonstrating that selection for large root diameter (hypocotyl diameter) in the seedling stage is a good index of the potential yield of a variety.

The number of vascular rings that could be counted in the cross-sections of roots also demonstrated that as plant density decreases ring number increases. The mangel had the least number of vascular rings among the varieties at each spacing. Sugar percentage and ring number show a perfect rank correlation in the 12-inch, 24-inch spacing and with the total variety means for these four varieties.

The width of vascular rings increased with the decrease in plant density for all varieties (Table 3). Only the data for ring No. 2 are shown since other ring widths were similar for each variety.

Table 1. Gross sugar, root weight, and sugar percentage for four varieties grown at three plant densities. Logan, Utah, 1977.

	Gross Sugar				Root Wt.. T/A				Sugar %			
	Spacing			Variety	Spacing			Variety	Spacing			Variety
Variety	6"	12"	24"	Mean	6"	12"	24"	Mean	6"	12"	24"	Mean
Mangel	3310	5190	3316	3939	18.22	28.83	21.79	22.95	9.02	9.00	7.60	8.54
53.13	3564	6924	5937	5475	14.14	23.53	20.13	19.27	12.52	14.72	14.75	14.00
D2	4677	7521	6752	6317	16.05	23.94	21.90	20.63	14.50	15.68	15.42	15.20
UI8	3162	6155	5074	4797	11.70	21.08	16.83	16.54	13.55	14.60	15.10	14.42
Space Mean	3678	6448	5270		15.03	24.34	20.16		12.40	13.50	13.22	
Overall Mean		5132				19.84				13.04		

	Gross Sugar			Root Wt.. T/A			Sugar %		
	Spacing	Variety	Var. x Spac.	Spacing	Variety	Var. x Spac.	Spacing	Variety	Var. x Spac,
LSD 0.05	488	564	976	1.92	2.23	3.86	0.36	0.41	0.71
Calc. F	30.71**	26.12**	2.60*	37.65**	11.45**	0.63NS	19.43**	448.85**	10.80**
C. V.		14.65			13.97			3.84	

Table 3. Width of vascular ring No. 2 for four varieties grown at three plant densities, Logan, Utah, 1977.

	Spacing			Variety
	6"	12"	24"	Mean
Mangel	6.25	8.65	8.75	7.88
53.13	4.40	7.95	10.05	7.47
D2	4.70	6.60	9.60	6.97
U18	4.45	7.05	8.90	6.80
Space Mean	4.95	7.56	9.32	
Overall Mean		7.28		
	Spacing	Variety	Var. x Spac.	
LSD 0.05	1.15	0.79	1.33	
Calc. F	29.93**	3.31*	2.85*	
C.V.		15.01		

Table 2. Top weight, root/top ratio, root diameter, and vascular ring number for four varieties grown at three plant densities. Logan, Utah, 1977.

	Top Wt. Lbs/Plot				Root Wt./Top Wt.			
	Spacing			Variety	Spacing			Variety
Variety	6"	12"	24"	Mean	6"	12"	24"	Mean
Mangel	81.00	61.00	43.00	61.67	1.65	3.63	3.73	3.00
53.13	116.00	140.00	93.00	116.33	0.90	1.25	1.64	1.26
D2	116.00	142.00	86.75	114.92	1.02	1.24	1.87	1.38
UI8	110.00	143.00	96.25	116.42	0.81	1.09	1.29	1.06
Space Mean	105.75	121.50	79.75		1.10	1.80	2.13	
Overall Mean		102.33				1.68		

	Spacing	Variety	Var. x Spac.	Spacing	Variety	Var. x Spac.
LSD 0.05	11.64	12.00	20.77	0.30	0.26	0.46
Calc. F	26.78**	41.71**	3.01*	25.71**	91.86**	8.34**
C.V.		14.54			20.43	

	Root Diameter				Number of Rings			
	Spacing			Variety	Spacing			Variety
Variety	6"	12"	24"	Mean	6"	12"	24"	Mean
Mangel	6.45	9.40	12.15	9.33	4.65	5.25	6.20	5.37
53.13	5.25	8.40	11.95	8.53	6.05	6.90	6.95	6.63
D2	5.30	8.40	12.75	8.82	6.00	7.20	8.35	7.18
UI8	4.85	7.80	11.80	8.15	5.90	6.85	8.05	6.93
Space Mean	5.46	8.50	12.16		5.65	6.55	7.39	
Overall Mean		8.71				6.53		

	Spacing	Variety	Var. x Spac.	Spacing	Variety	Var. x Spac.
LSD 0.05	0.75	0.53	0.93	0.34	0.48	0.83
Calc. F	165.22**	7.11**	1.64NS	50.33**	22.97**	1.53NS
C.V.		8.47			8.72	

COMPETITION OF CANOPY-TYPE AT THREE PLANT DENSITIES

J. C. Theurer and D. L. Doney

Adjacent sugarbeet plants compete for nutrients, water, light, and other factors. This experiment was established to note the competitive effects of plants having different canopy characteristics when planted in 22-inch rows 6, 12, and 24 inches apart in the row. In addition to canopy characteristics, the seven entries included in the study varied greatly in their yielding ability and sugar content. The entries are listed in Table 1. The field was marked in 1-foot grids, and four replicates of 2-row plots in each spacing were planted in hills, using a hand planter. At the four-leaf stage of development, the clusters of plants were thinned to a single plant. The stand in the test was almost perfect. At harvest in September, the root weight and top weight were determined in the field. Sugar percentage was determined in the laboratory by the cold-digestion method.

RESULTS

Gross sugar, root weight, and sugar percentage are shown in Table 2. Significant differences were observed for spacing, varieties, and for the interaction between varieties and spacing. Generally, the closer the spacing, the greater was the yield. However, L19 had the lowest yield and C17 the highest yield at the 12-inch spacing. There was a fair epidemic of curly top in these plots and the Blanca mangel, and L19 yields were less than they might have been in the absence of the disease. While there was a variety x space interaction, there was no apparent association of canopy-type and yield in the different densities. For example: GWD2, an erect type, and 28D36, a prostrate type, were the highest in yield; whereas, 21F2, errect, and 21F3, prostrate, were low in gross sugar and root weight.

Sugar percentage also was highest for the 6-inch spacing. GWD2 and 21F3 had a slightly higher sugar percentage at the 12-inch spacing than they did at 6 or 24 inches; however, they were not significantly different from the 6-inch spacing.

The top weight and root/top ratios are presented in Table 3. Top weight was similar to root weight in that the 6-inch spacing had significantly the greatest weight. There was no difference in the 12- and 24-inch spacings when summed over varieties. As expected, the mangel had the smallest top and GWD2 the largest top of the entries. Variety 21F3 had significantly less top weight at 12-inch than at the other two spacings. No consistent interaction of top weight, spacing and canopy-type was evident.

The root/top ratios (Table 3) for the three spacings were similar. However, significant differences were observed for varieties in the three spacings. GWD2, the mangel, and 28D36 entries had higher ratios at the 12-inch spacing, 21F2 and 21F3 at the 6-inch spacing, and L19 and C17 at the 24-inch spacing.

The growing season for this test was relatively short (124 days compared to our regular 165-day season), and some differences may have occurred in a longer

growing period. However, based on the data we obtained, we would have to conclude that canopy structure, per se, even under different competition densities, is of little consequence in determining root yield, top yield, or sugar percent. Genotypes differ in their response to different densities of planting in 22-inch rows, regardless of the type of canopy they possess.

Table 1. Characteristics of entries in canopy density plant test. Logan, Utah, 1977.

Entry	Canopy Type	Sugar %	Root Yield
21F3	Prostrate, medium sized leaf	Low	Medium
28D36	" " " "	High	"
C17	Semi-erect, large leaf	Low	High
Blanca	" " "	Very Low	Very High
L19	Erect, small leaf	Very High	Medium
21F2	" , medium sized leaf	Medium	"
GWD2	" , large leaf	"	High

Table 3. Top weight and root/top ratios for canopy plant density study. Logan, Utah, 1977.

	Top Wt. Lbs/Plot				Root Wt./Top Wt.			
	Spacing			Variety	Spacing			Variety
Variety	6"	12"	24"	Mean	6"	12"	24"	Mean
21F3	29.88	23.50	28.12	27.17	1.78	1.62	1.33	1.58
28D36	43.12	29.62	31.38	34.71	1.68	1.93	1.58	1.73
C17	40.50	42.75	33.50	38.92	1.35	1.40	1.45	1.40
Blanca	25.88	15.12	15.12	18.71	2.38	3.34	2.90	2.87
L19	32.25	27.38	25.50	28.38	1.12	1.07	1.32	1.17
21F2	37.25	28.25	28.88	31.46	1.11	0.97	1.05	1.04
GWD2	48.12	41.75	39.62	43.16	1.44	1.54	1.51	1.50
Space Mean	36.71	29.77	28.88		1.55	1.70	1.59	
Overall Mean		31.79				1.61		

	Spacing	Variety	Var. x Spac.	Spacing	Variety	Var. x Spac.
LSD 0.05	5.14	3.74	5.94	0.24	0.22	0.04
Calc. F	8.13**	44.40**	2.01**	0.74 NS	59.75**	2.75**
C.V.		14.74			18.25	

Table 2. Gross sugar, root weight, and sugar percentage for canopy plant density study. Logan, Utah, 1977.

Variety	Gross Sugar				Root Wt. T/A				Sugar %			
	Spacing			Variety	Spacing			Variety	Spacing			Variety
	6"	12"	24"	Mean	6"	12"	24"	Mean	6"	12"	24"	Mean
21F3	6039	4212	1475	4809	20.9	14.5	14.9	16.8	14.4	14.6	14.0	14.3
28D36	8657	6731	5879	7089	28.4	22.2	19.7	23.4	15.3	15.2	15.0	15.2
C17	6155	6444	5224	5941	21.2	23.3	19.1	21.2	14.5	13.8	13.8	14.0
Blanca	4606	3599	2556	3587	24.1	19.8	16.5	20.1	9.6	9.1	7.8	8.8
L19	4764	3768	4041	4191	14.2	11.5	13.2	13.0	16.8	16.3	15.3	16.1
21F2	5121	3202	3675	3999	16.4	10.5	12.4	13.1	15.6	15.2	15.1	15.3
GWD2	8235	7708	6569	7504	27.5	25.1	23.5	25.4	15.0	15.3	14.0	14.8
Space Mean	6225	5095	4588		21.8	18.1	17.0		14.5	14.2	13.6	
Overall Mean		5303				19.0				14.1		

	Gross Sugar			Root Wt. T/A			Sugar %		
	Spacing	Variety	Var. x Spac.	Spacing	Variety	Var. x Spac.	Spacing	Variety	Var. x Spac.
LSD 0.05	552	591	1023	1.82	1.92	3.32	0.52	0.60	1.04
Calc. F	18.45**	55.68**	2.16*	15.29**	51.54**	2.79**	5.60**	129.29**	1.06NS
C.V.		14.33			13.04			5.46	

THE EFFECT OF TOP vs ROOT ON SUGAR CONTENT

J. C. Theurer and R. E. Wyse

An experiment was initiated in 1977 to ascertain the influence of the top vs the root for sugar content. Three lines differing in sugar content and root yield were selected for the study and are listed below:

	Sugar %	Root Yield
L19	High	Low
C17	Medium	Medium
Mangel	Low	High

Seed was planted in soil in Japanese paper pots in the greenhouse at weekly intervals over a period of a month. They were irrigated daily with nutrient solution. Grafts were made of the seedlings in all nine possible combinations, using seedling plants in the 2-leaf stage of growth for stocks and in the cotyledon stage for scions. After the graft was established, the leaves were removed from the stock portion of the plant. Then the plants were transplanted into soil in 6-gallon buckets and kept in the greenhouse until June. Af this time, they were transferred to the field. Holes were dug on 5-foot centers, and the buckets were inserted into the soil until only 2 inches of the lip of the buckets were exposed above the ground.

Twenty single-plant replicates of each of the nine grafted combinations were established in the field. Each plant was watered daily with the same volume of a complete fertilizer mixture. Each week the plants were sprayed to control insects. In spite of this precaution, we observed severe curly top infection in the plants. The infection was not uniform but of a spotty nature. Curly top particularly hurt the growth of plants having mangel tops. Just before harvest, the plants were scored for curly top on a 1 to 5 scale (1 = no symptoms; 5 = dead or near dead plant. The plants were harvested September 8, 1977. The crowns of each beet were trimmed to remove all leaves. Roots and tops were then weighed.

Beets were divided into halves longitudinally, and one-half was further divided into crown and root portions by cutting each beet at the graft union.

The crown and root portions of these halves of beets were independently shredded with a vegetable shredder, and approximately 20 grams of tissue were blended with the proper quantity of sub-lead acetate solution. Sugar percent was determined by the cold digestion method for each root and crown.

The other half of each beet was used to count vascular rings, for photographs, and to see what influence or change of sugar percent occurred in either direction from the graft union. To test the latter, two or three half-inch width slices were cut in either direction from the graft union. Each slice of beet was then shredded, blended, and evaluated for sugar percentage.

RESULTS

The root weight, top weight, sugar percentage of roots and crowns, and curly top score are given in Table 1. The data demonstrated that both the root and the crown have an influence on sugar percentage. However, the greatest influence is due to the root. C17 grafts had larger and better conditioned roots than did

L19, or the mangel grafted beets. This was primarily due to curly top infection. In particular, the beet weight of the mangel grafts was considerably less than expected because of their curly top infection. The C17/C17 graft also showed the largest top growth (Table 1). All grafts with L19 had a small crown, and those with the mangel had a large crown (Table 2). When L19 was used as scion, the crown was tapered conically from the graft union to the apex of the crown. The reciprocal grafted beets exhibited an acorn effect with the crown portion growing more rapidly and bulging out over the small roots of the L19 stock.

L19 stimulated increased sugar percentage in the grafts with C17, and the mangel and C17 stimulated increased sugar in grafts with the mangel (Table 1). Conversely, the mangel had an effect of decreasing sucrose when grafted with L19 or C17. A similar influence was noted for the number of vascular rings (last column Table 2). L19 had an average of about 12 rings; C17, 10 rings; and the mangel about 7 rings at harvest. Grafts with the mangel as scion with L19 and C17 stocks tended to decrease the number of vascular rings. Conversely, L19 and C17 scions tended to influence an increase in ring number when they were grafted to mangel stocks.

As near as we could tell by visual inspection, the vascular rings in the two portions of the graft tended to match up at the graft union. However, we did not study these plants histologically to be certain. One could reason that the influence of one portion of a grafted root on the other for sugar percentage was the result of an altered cell size at the graft union. For example, a mangel scion might tend to increase cell size in the stock portion of a graft to L19, and, conversely, the L19 might tend to reduce the size of the mangel cells growing in the scion portion adjacent to the graft union. An attempt was made to see if there were differences in sugar percentage in the areas adjacent to the graft union from the balance of the beet by taking slices in either direction from the graft union. There was little difference between the check grafts and those between different genotypes. In general, the sugar decreased from the graft union in either direction toward the crown apex and the root tail, as normally observed when a beet is analyzed for sugar from the widest area of the root in either direction toward crown or root tail.

We plan to study grafted populations next year to further substantiate our 1977 observations.

Table 1. Root weight, sugar percentage, top weight, and curly top disease score for grafted beets. Logan, Utah, 1977.

Graft Combination Scion/Stock	Root Weight gms	Crown Sugar %	Root Sugar %	Top Weight gms	Curly Top Score 1/
L19/L19	613	14.8	14.8	319	3.3
C17/L19	728	12.7	14.1	351	3.1
Mangel/L19	654	11.0	13.6	198	3.8
L19/C17	603	13.6	13.0	282	3.5
C17/C17	1235	11.4	12.0	575	2.6
Mangel/C17	906	9.5	11.8	344	3.5
L19/Mangel	835	10.6	9.6	359	3.0
C17/Mangel	796	9.9	9.3	265	3.4
Mangel/Mangel	590	8.3	8.1	172	4.2
Mean	759	11.2	11.8	318	3.4
LSD 0.05	183	0.93	0.98	125	0.6

1/ Based on 1 = no symptoms, 5 = near dead or dead plant.

Table 2. Percent of total root weight in crown and root portions and number of vascular rings in root portion of the beet-grafting study. Logan, Utah, 1977.

Graft Combination Scion/Stock	Percent Total Root Wt. Crown (Scion)	Percent Total Root Wt. Root (Stock)	No. Vascular Rings in Root (Stock)
L19/L19	39.8	60.2	11.9
C17/L19	48.2	51.8	12.0
Mangel/L19	57.9	42.1	11.4
L19/C17	25.2	74.8	10.0
C17/C17	34.7	65.3	10.0
Mangel/C17	37.5	62.5	9.1
L19/Mangel	15.8	84.2	8.7
C17/Mangel	23.8	76.2	7.8
Mangel/Mangel	28.7	71.3	7.3
Mean	34.7	65.2	9.8
S.E.	13.4	13.4	1.48

COMPARISON OF THE SUCROSE STORING MECHANISM IN SUGAR AND FODDER BEETS

Roger Wyse

In an attempt to determine the mechanism controlling sucrose accumulation in sugar beets, a biochemical and morphological comparison of a fodder beet (Blanca, KWS) and sugar types (D-2, GW; L53xL19) was made throughout a growing season.

Sucrose Content: The sucrose content of the sugar types increased rapidly during July and then increased in a somewhat slower but linear fashion until final harvest (Figure 1). The fodder beet also increased at a linear rate during September and October. Its rate was, in fact, the same as the rate for the sugar types during the final two months of the growing season.

The dry matter content of the fodder beet is approximately 8 to 9 percentage points lower than the sugar types throughout the growing season. Therefore, the fodder beet contains considerably more water than the sugar types. However, the high water content does not account for the low percent sugar. On a dry-weight basis, the sucrose content of the fodder beet is still well below that of the sugar types.

Enzyme Activity: The activity of several enzymes involved in sucrose metabolism was monitored during the last two months of the growing season.

1. Sucrose synthetase: This reversible enzyme catalyzes both the synthesis (forward) and degradation (back) of sucrose in the root.

2. Neutral invertase: This enzyme catalyses the hydrolysis of sucrose and is most active at pH 7.2.

3. Acid invertase: The hydrolytic activity of this enzyme is very low in the beet root; is most active at pH 5.0.

In general, the activity of all the enzymes decreased during the growing season. Since the data were expressed on a dry-weight basis, the decrease may be an artifact of a more rapid increase in dry matter than enzyme activity (Figure 2). Only the activity of acid invertase shows a good consistent relationship between the sucrose content of the varieties and enzyme activity. Its greater hydrolyic activity in the fodder beet may explain, in part, the lower sucrose concentration in the fodder beet.

Sucrose Uptake: Disk samples of root tissue were exposed to radio-active sucrose glucose and fructose, and the rate of uptake into the storage vacuole of each variety determined. Labeled sugar held by the tissue after a 30-minute extraction with cold water was assumed to be located in the storage vacuole.

There was no significant difference in the uptake of sucrose by the three varieties (Table 1). The disks represented a constant volume of each tissue type; therefore, on a dry-weight basis, the fodder beet was capable of taking up considerably more sucrose than the sugar types. These data show no cause and effect relationship between the uptake capacity of the tissue and the sucrose concentration in that tissue. The rates of glucose and fructose uptake were much lower than that of sucrose in all varieties. The fodder beet was inter-

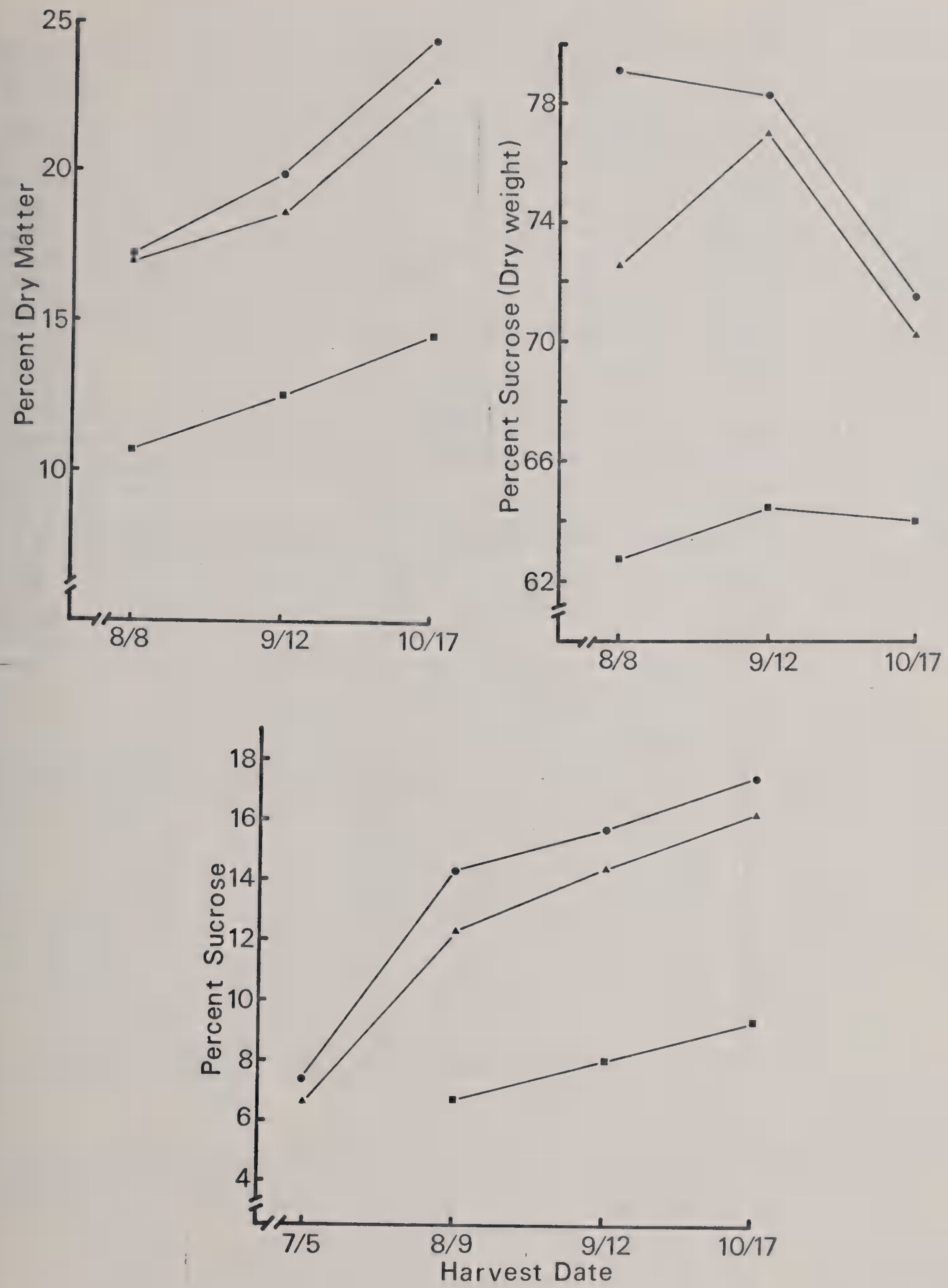

Figure 1. Relationship between percent dry matter, percent sucrose, and percent sucrose on dry weight in Blanca (■), L53xL19 (●), and GWD-2 (▲) during a growing season.

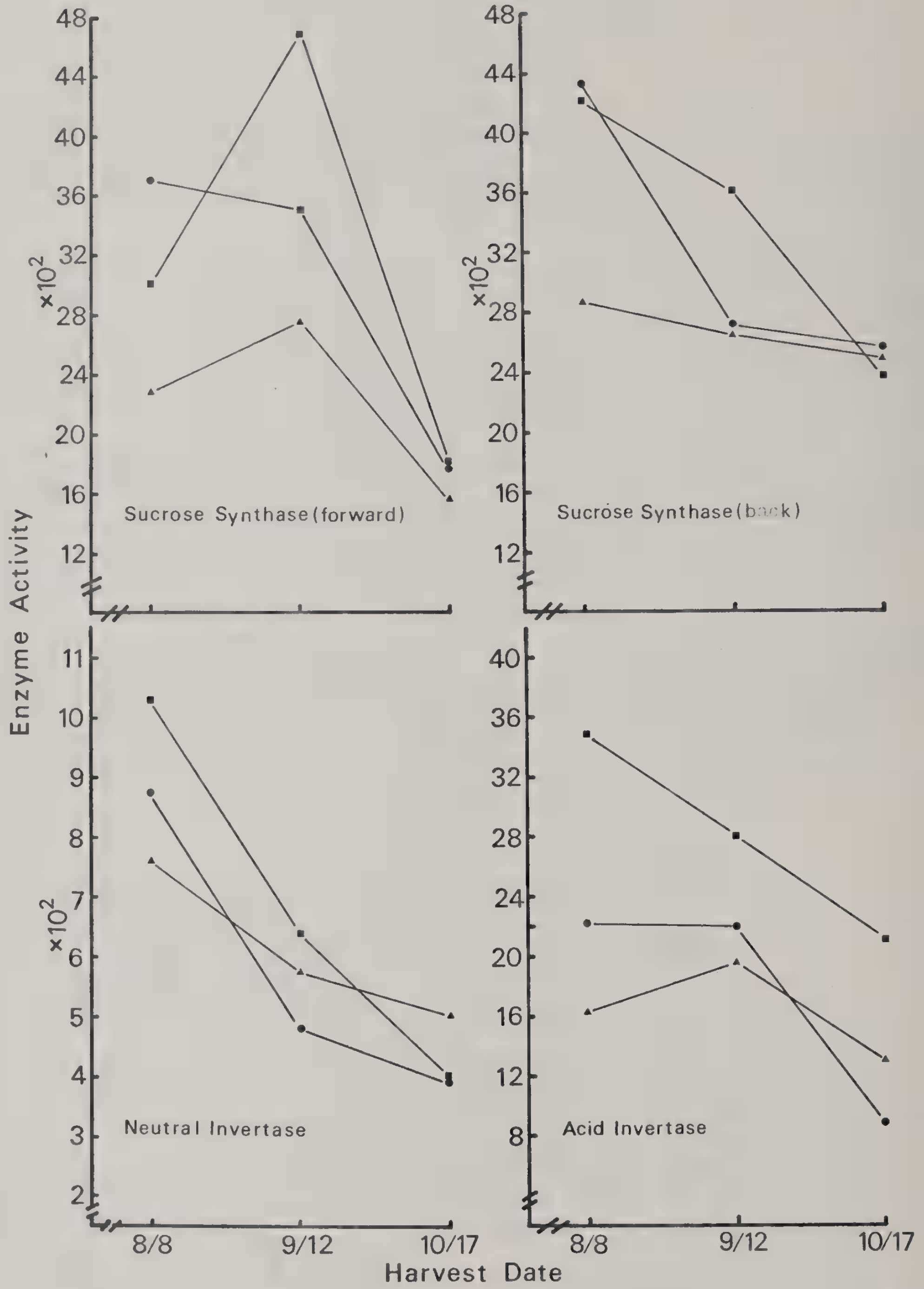

Figure 2. Activity of several sucrose metabolizing enzymes during a growing season in Blanca (■), L53xL19 (●), and GWD-2 (▲).

mediate to both the sugar types and would show a much higher rate of uptake on a dry-weight basis.

If two sugars move across a membrane by the same "carrier," each sugar should competitively inhibit the uptake of the other. This principle was used to determine if sucrose, glucose, and fructose were taken via the same mechanism in each variety (Table 1). Glucose and fructose strongly inhibited the uptake of sucrose in all three varieties. The similarity in the degree of inhibition would indicate the same mechanism was operating in each case. Sucrose had little effect on the uptake of glucose and fructose. The very similar pattern of inhibition indicates a similar biochemical mechanism of uptake in each case. Therefore, the greater capacity of the sugar types cannot be explained on the basis of biochemical differences.

Morphological Characteristics: Since we now know that sucrose moves from the phloem to the center of the ring by diffusion, it is entirely possible that the rate-limiting step is the rate of diffusion. The low-sugar fodder beet produces large cells and very wide rings (Table 2). The sugar types L53xL19, in particular, produce narrow rings and many small cells near the vascular bundles. The path for diffusion is, therefore, much shorter in the sugar types, and the sucrose passes many small cells as it diffuses into the ring. Cells further from the vascular area are exposed to lower concentrations of sucrose and, therefore, take up less. Experiments to substantiate this theory are currently in progress.

Table 1. Interaction between sucrose, glucose, and fructose during uptake into the storage cells of Blanca, L19xL53, and D-2.

Variety	Uptake Sugar	Uptake Rate mm/3 hrs/20 disks	Inhibition - Percent		
			Sucrose	Glucose	Fructose
D-2	Sucrose	5.49 $\pm$ 0.33	--	81.3	59.4
	Glucose	0.56 $\pm$ 0.05	-11.4	--	- 6.8
	Fructose	0.29 $\pm$ 0.03	2.6	74.1	--
L53xL19	Sucrose	5.17 $\pm$ 0.36	--	86.3	68.6
	Glucose	0.99 $\pm$ 0.01	7.7	--	2.7
	Fructose	0.88 $\pm$ 0.07	5.1	31.8	--
Blanca	Sucrose	5.72 $\pm$ 0.71	--	82.5	61.4
	Glucose	0.69 $\pm$ 0.02	-15.3	--	-14.0
	Fructose	0.48 $\pm$ 0.07	12.8	63.1	--

Table 2. Cell number, cell volume, and ring width in fodder and sugar types. Measurements are from ring 3 at final harvest.

	Width mm	Cell Number 1/	Cell Volume $CM^3 \times 10^{-8}$ Max. 2/	Ave. 3/
Blanca	10.2	98	189.0	58.8
D2	5.7	87	50.5	14.6
L53xL19	4.2	87	32.8	5.9

1/ Number of cells across ring from cambium of Ring 2 to cambium of Ring 3.

2/ Maximum cell size at center of ring.

3/ Average cell volume for entire ring.

ISOZYME SURVEY

D. L. Doney

Isozymes are different structural forms of a given enzyme. These structural differences have been shown to be the result of single gene mutations. In recent years, a number of reports have related certain isozymes to heterosis or hybrid vigor.

This past year we conducted a survey of the isozymes of some of the major enzymes in sugarbeet. The isozymes studied were estrase, peroxidase, catalase, alcohol dehydrogenase, PEP carboxylase, glutamic dehydrogenase, and glucose 6-phosphate dehydrogenase. The survey was made on a series of hybrids and their inbred parents. Hybrids had one parent in common.

Identification of allelic isozymes of esterase and glucose 6-phosphate dehydrogenase was achieved. One gene for G6-PD (g_2) had a recessive allel for the absence of the g_2 isozyme; i.e., all inbreds did not have the g_2 isozyme; and, when one parent of a hybrid carried the g_2 isozyme, it was also present in the hybrid.

Several segregating esterase isozymes were discovered. E_3 isozyme showed a peculiar characteristic. It was present in L10 and L21 but absent in L29 and in the L29xL10 and L29xL21 hybrids. This suggests that absence is dominant, and that the E_3 isozyme is a recessive mutation. The normal case is that the absence of a particular isozyme denotes a recessive mutation.

A hybrid esterase isozyme (E_6) was observed in all hybrids. It was absent in all the inbreds. The intensity of the (E_6) hybrid isozyme appeared to depend on the absence or presence of the E_5 and E_7 isozymes in the parents; however, inbred L35 had both E_5 and E_7 but no E_6. A hybrid isozyme usually results from a dimmer enzyme that separates and recombines at random in vitro. This theory explains some of the variation obtained; i.e., crosses between inbreds having the E_5 and inbreds having the E_7 isozymes resulted in hybrids with all three isozymes (E_5, E_6, E_7). However, some crosses did not follow this pattern. Inbreds L29, L36, L38, L53, and 00.5 had only the E_7 isozyme, yet crosses among these inbreds produce hybrids with all thee isozymes. These phenomena need to be investigated more extensively in segregating populations and in other crosses.

THE EFFECT OF CHLORINA AND FEATHER LEAF MUTANTS ON YIELD AND SUGAR PERCENTAGE

J. C. Theurer

An experiment was conducted in 1976 to note the effect of chlorina, plantain leaf, and feather leaf mutants vs normal plants for root yield and sugar content. The selected populations were planted in 4-row plots in standard 22-inch rows, 40 feet long. We planned to thin two adjacent rows to normal and the other two to mutant plants and have paired comparisons between the adjacent 2-row plots. However, the stand was not sufficient for us to thin to mutants in the designated plots. In addition, the plantain populations showed very poor segregation for the mutant character at thinning time. Thus, all plots were thinned to plants 12 inches apart in the row with an effort made to have as many mutant as normal plants in each row. At harvest, October 21, 10 mutant plants and 10 normal plants were selected at random from each 2-row plot for root weight and sugar percent determination. Plantain leaf populations were discarded since they failed to segregate sufficient mutants to make valid comparisons.

Data on root weight, top weight, and sugar percentage are given in Table 1. Normal plants consistently had a higher root weight and a higher sugar percentage than chlorina or feather leaf mutants. Feather leaf always had a higher top weight and chlorina a lower top weight than their normal equivalents.

It would appear that the root characteristics of the feather leaf mutant are very dominant since they were manifest in almost every F_2 plant having the feather-leaf type foliage. In normal plants, there is probably an excess of chlorophyll relative to the amount required for optimum yield. The chlorina mutant will produce good foliage and good sized roots; however, the chlorophyll available in the plant for carrying out the photosynthesis process is not available in sufficient quantity to reach the threshold required for optimum production. This is evident by the reduction in both sugar content and root yield.

Table 1. Mean root weight, top weight, and sugar percentage for chlorina and feather leaf mutants vs normal plants - Logan 1977.

Variety Code No.	Root Wt. (Lbs) Mutant	Root Wt. (Lbs) Normal	Top Wt. (Lbs) Mutant	Top Wt. (Lbs) Normal	% Sugar Mutant	% Sugar Normal
Chlorina						
1302	9.0	12.0	14.3	16.0	14.3	15.0
1304	10.5	17.5	13.5	17.5	14.2	13.9
1310	9.5	14.2	13.5	18.7	14.0	14.7
1312	13.2	20.7	17.0	21.8	13.7	14.3
Feather Leaf						
1301	16.0	18.8	26.2	16.7	12.3	13.3
1303	16.0	18.3	31.2	24.7	12.4	14.0
1309	15.3	18.0	23.0	17.0	12.6	13.2
1311	15.5	18.8	32.8	24.7	12.4	13.9
High Yield Check		21.7		23.2		15.4
High Sugar Check		19.3		22.0		16.3
Overall Mean	16.6		20.71		14.09	
LSD 0.05	9.19		6.13		0.68	

PATHWAY OF SUCROSE MOVEMENT FROM THE VASCULAR TISSUE INTO THE STORAGE CELL: EVIDENCE FOR APOPLASTIC MOVEMENT

Roger Wyse

Over the past several years we have made considerable progress towards determining the mechanism of sucrose uptake into the vascuole of sugarbeet root cells. Our objective is to define the pathway from the vascular phloem cells into the storage cells throughout the interring area.

Of primary importance is the determination of whether the sucrose moves through the free space between cells (apoplast) or through the cells themselves (symplast). Our previous studies on sucrose uptake into the vacuole were based on the assumption that sucrose moved in the free space. However, we had no experimental evidence proving this assumption.

Experimental Evidence: If sucrose moves through the free space as it spreads horizontally throughout the root, it should be possible to wash the translocated sucrose out of the root as it moves between the cells. After the sucrose has been taken up by the cells, it can no longer be washed out. If sucrose moves through the cells (symplastic movement), the sucrose could not be washed out at any time.

Sugarbeet plants growing in a competitive stand in the field were covered with a plastic bag and $^{14}CO_2$ released inside. The plants were allowed to fix carbon dioxide for 30 minutes after which time the bags were removed. After the $^{14}CO_2$ exposure, roots were harvested at various time intervals over a 24-hour period. Immediately after harvest, a section was cut out of the root, cut into 1 mm thick slices with a hand microtome, and disks (1x5mm) were punched out of the slices. One-half of the disks were washed for 30 seconds to rid the tissue of radioactive sucrose on the surface of the tissue. The remainder were washed for 60 minutes in running tap water to remove any radioactive sucrose in the free space.

The results indicated that radioactive sucrose was translocated to the root within 30 minutes after exposure (Table 1). The percentage of the translocated sucrose which could be washed out (located in the free space) ranged from 88 percent after 30 minutes to only 5.4 percent after 24 hours.

This data support the theory that sucrose moves in the free space.

Table 1. Percent of translocated sucrose washed out of root tissue during a 60 minute wash at various times after $^{14}CO_2$ fixation.

Time after $^{14}CO_2$ Exposure	Percent Washed Out
30 min.	88
60 "	63
90 "	53
2 hr.	29
4 "	24
6 "	15
24	5.4

To further substantiate the apoplastic theory, a similar pulse-chase experiment was conducted, but inhibitors were injected into the root prior to $^{14}CO_2$ exposure. From previous biochemical studies, it was determined that glucose is a potent inhibitor of sucrose uptake from the free space of the root. These studies also indicated that the site of inhibition was on the outside of the cell. Therefore, glucose injected into the free space of a sugarbeet root should prevent sucrose uptake if sucrose moves in the apoplast. Glucose would have no effect if sucrose moves solely in the symplast.

Small holes were made in a "mature" sugarbeet root with a 5cm 18ga hypodermic needle. The hole was filled with the appropriate solution and the opening connected via a small bore glass tube to a 5ml container. Using this technique, the solution could be continuously supplied to the root over an extended period of time.

Solutions of water, 0.1M sucrose and 0.1M glucose, were injected into the root 12 hours prior to $^{14}CO_2$ exposure and continued until the roots were harvested 24 hours after a 4-hour $^{14}CO_2$ exposure.

A sample of tissue extending 1.5cm on all sides of the injection hole was sliced into 1mm slices and extracted as described previously.

The results indicate that twice as much of the translocated sucrose was washed out of tissue exposed to a 0.1M glucose as in the water control (Table 2). Therefore, sucrose was diffusing through the free space around the cells and was not taken up in the presence of glucose. These data further confirm the participation of the free space in the movement of sucrose horizontally in the sugarbeet root.

Since all sugarbeet root cells (vascular, parenchyma, fodder, and sugarbeet) have similar capacities for storing sucrose in the free space, the rate of diffusion away from the vascular area may be the factor limiting sucrose accumulation in the sugarbeet root.

Table 2. Amount of translocated sucrose in the free space of sugarbeet root tissue in the presence of water, 0.1M sucrose, or 0.1M glucose.

	Percent Washed Out
Water	27.3
Sucrose (0.1M)	33.5
Glucose (0.1M)	52.0

IV. STORAGE AND RESPIRATION

EFFECT OF HARVEST METHODS ON THE RESPIRATION RATE AND SUCROSE LOSS OF SUGARBEET ROOTS DURING STORAGE

Roger Wyse

The severity of injury inflicted on sugarbeet roots during harvesting and handling have a very profound effect on their storage life. Respiration rates are increased in direct relationship to severity of injury. Infection by Botrytis and Penicillium is dependent on surface injury. Once the surface is broken, infection by these fungi occurs, and the degree of rot is then related to storage temperature and length of storage.

Therefore, an important aspect of any improved storage management program is to identify points of significant injury and to develop improved handling procedures in order to minimize their effect.

The objective of this study was to determine the effect of harvest injury on the respiration rate of sugarbeet roots immediately after harvest and on sucrose losses during 120 days of storage.

MATERIALS AND METHODS

Sugarbeet roots were subjected to the following harvest procedures:

1. Hand harvested - untopped
2. " " - topped
3. " " - flailed
4. Machine harvested - flailed
5. " " - topped

Immediately after harvest, each treatment was divided into 30 samples of 10 roots each. Fifteen samples were selected for immediate analysis, and fifteen were prepared for storage. Ten of the storage samples were placed in the respirometer for respiration analysis. The remaining five replications were stored in polyethylene bags. The samples were held at 10C for the first 50 days of storage after which time the temperature was reduced to 5C until the samples were removed after 120 days total storage time. None of the samples were washed.

Chemical analysis for percent sucrose and reducing sugars was made at harvest and after storage. All analyses were corrected for weight loss in storage.

RESULTS

Respiration rates during the first 12 days of storage are given in Figure 1. The respiration rate of the more severly injured machine-harvest roots was significantly higher than the hand-harvested controls. Removal of the crown reduced the respiration rate slightly over non-topped roots. Flailing had no effect on respiration rate.

After 50 days at 10C, the respiration rates were again measured (Table 1). The respiration rate of the machine-harvested roots increased 44 percent while the hand-harvested controls increased 29 percent. The advantage of crown removal seen in the first 12 days had disappeared.

After 120 days of storage (50 days at 10C and 70 days at 5C), the respiration rate was again measured but at 5C (the current storage temperature) instead of 10C as in the previous measurements (Table 1). The respiration rate of the machine-harvested roots had increased dramatically over the hand-harvested controls. The topped roots were now respiring at a much higher rate than the untopped roots. The topped roots had appreciable mold growth in the hollow area of the crown. This growth would explain their increased respiration rate.

Sucrose loss and reducing sugar accumulation closely paralleled the respiration rates after 120 days of storage. The machine-harvested roots lost considerably more sucrose than did the hand-harvested controls. The topped roots also lost more sucrose than the untopped roots. Reducing sugar accumulation was much higher in the machine-harvested root; particularly those which were machine-topped. The reducing sugar content of the roots reflected the amount of mold growth on the injured areas; particularly those in the crown region.

DISCUSSION

During the initial 30 days of storage, there was a slight advantage in both impurity level and respiration rate in removing the crown from the roots. However, after 50 days, the respiration advantage was lost and the impurity level in the topped root greatly exceeded that of the untopped root. These impurities (reducing sugar) were primarily the result of mold growth.

The importance of harvest injury on the economic storage life of the sugarbeet root is readily apparent. Much of the secondary effects of injury, such as mold growth, can be minimized by maintaining cool pile temperatures and using fungicides. However, some attention should be given to redesigning the current harvest and handling methods for sugarbeet to minimize injury while still cleaning the roots sufficiently for storage.

Table 1. Storage respiration rates of sugarbeet roots subjected to various harvesting procedures.

Treatment	Storage Period, Days		
	12[1/]	50[1/]	120[2/]
		$mgCO_2$/Kg hr	
Hand-harvested-flailed	6.2	8.3	11.9
Hand-harvested-topped	5.4	7.2	16.9
Hand-harvested-untopped	6.4	7.6	12.2
Machine-harvested-topped	7.0	10.5	28.0
Machine-harvested-flailed	7.5	10.5	19.3
LSD	1.0	1.1	4.2

1/ Respiration measured at 10C

2/ Respiration measured at 5C

Table 2. Effect of harvest method on sucrose loss and reducing sugar accumulation during 120 days of storage.

		Sucrose	Reducing Sugars
		Kg/Ton	mg/Kg
Hand-harvested-untopped	At harvest	180	1019
	Change	-8	+1311
Hand-harvested-topped	At harvest	184	691
	Change	-17	+5906
Hand-harvested-flailed	At harvest	176	865
	Change	-10	+1628
Machine-harvested-flailed	At harvest	176	887
	Change	-27	+4913
Machine-harvested-topped	At harvest	170	784
	Change	-37	+12,252

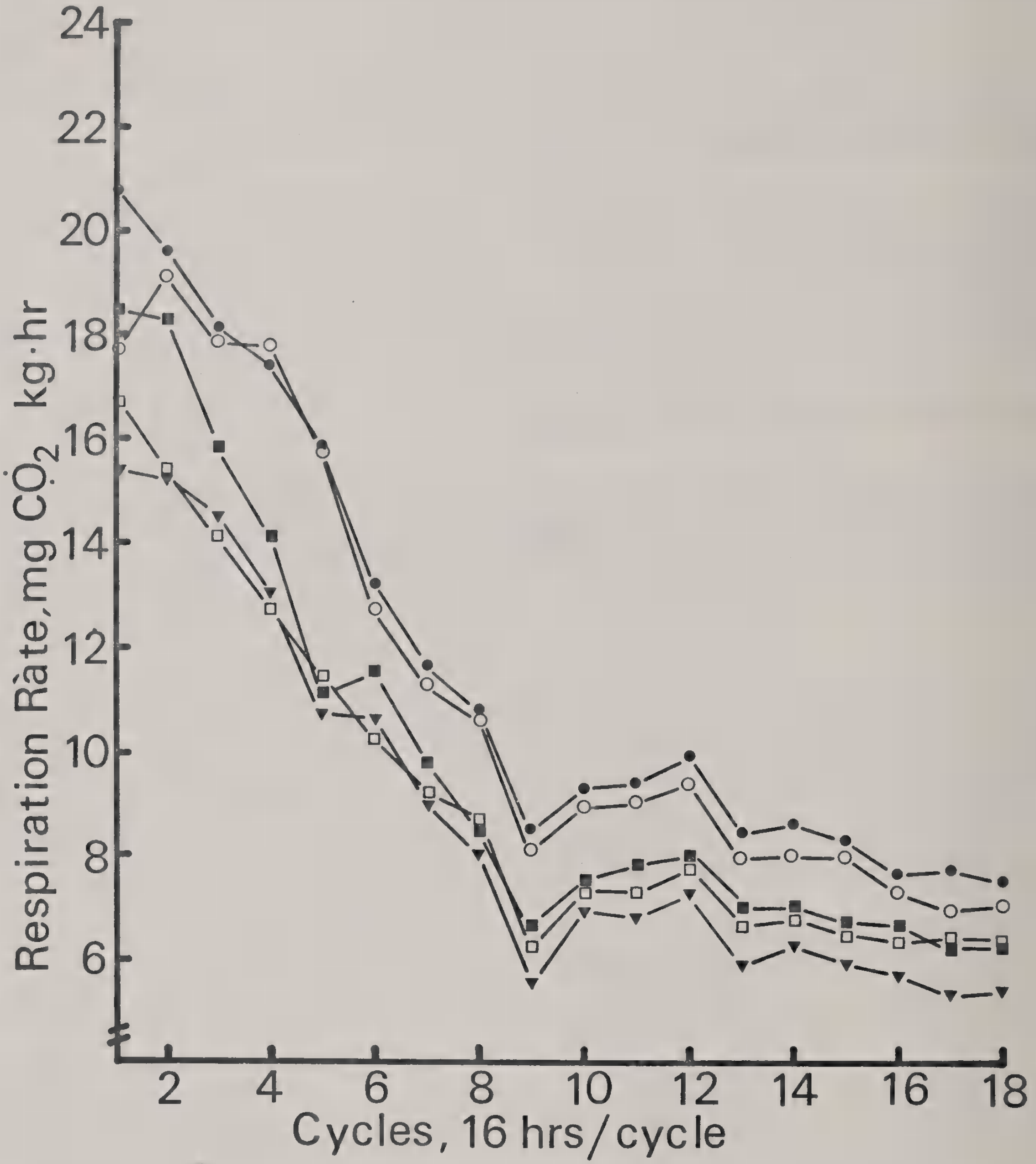

Figure 1. Effect of various harvest treatments on the respiration rate of sugarbeet root during the initial 12 days after harvest. Hand-harvested - untopped, □ ; hand-harvested - topped, ▼ ; hand-harvested - flailed, ■ ; machine-harvested - topped, ○ ; machine-harvested - untopped, ● .

IS FORCED VENTILATION OF SUGARBEET STORAGE PILES WORTH THE HASSLE?

R. E. Wyse and R. M. Holdredge

Forced ventilation of sugarbeet storage piles has been advocated for many years. It has the advantage of utilizing ambient cooling air more effectively, reducing "hot" spots, and should provide a reduction in sucrose losses. However, the capital investment for fans, ducts, and power can be significant. Additional labor is required at piling time to install ducts (assuming above ground ducting) and at reloading to remove ducts. Do the advantages outweigh the disadvantages? How much ventilating capacity is needed in various geographic areas?

In an attempt to answer these and other questions, we have utilized a computer simulation model of a sugarbeet storage pile. Such a model allows rapid comparison of variables and gives a relative comparison of sucrose loss between treatments. Although the numbers generated are an excellent approximation of actual losses, experiments at each location should be conducted in order to obtain actual cost effectiveness data.

For the data presented in this report, geographical comparisons are based on five-year average temperatures. The sucrose losses predicted represent losses due to respiration alone. These respiration losses should represent 85 to 90 percent of the losses incurred during the 48-day storage period represented in this study.

To compare the popular management plan of first-in first-out with the opposite extreme of first-in last-out, the piling period was divided into 4-day units. Piling occurred over a 16-day period and removal over a 48-day period. Therefore, it took 12 days to process each 4-day piling increment.

Table 1 presents the comparison of sucrose losses at Garland, Utah; Saginaw, MI; Moorhead, MN; Longmont, CO; and Moses Lake, WA in simulated storage piles ventilated at rates of 10, 20, and 30 cfm/T, or cooled by free convection alone. Also compared are the first-in first-out and the last-in first-out reloading schemes. The sucrose losses are the average loss for all beets stored; i.e., the loss during 32 days of storage.

Within the locations tested, Saginaw had the highest losses and Fargo the lowest. The primary factor contributing to the higher losses in Saginaw was the lack of low night temperatures during October. The model does not turn the ventilation fans on until the outside air will effectively cool the pile. (See Sugar Beet Research, 1976, p. B56.) This lack of cool night temperatures also increased the fan capacity necessary to effectively cool the pile; i.e., the lack of a differential between pile temperature and the outside air could be partially compensated for by increased air volume. The very low night temperatures at Fargo facilitate convective cooling but forced ventilation still showed a significant advantage.

The comparison of processing sequence shows a slight advantage for the last-in first-out (LF) scheme. The reason for this is the following: The respiration rate of the sugarbeet root is very high during the first 10 days of storage. The LF scheme removes the last piling increment before it has gone through this 10-day high respiration period. After sugarbeets have gone through the initial

high respiration period, removal sequence is of little or no consequence. Note that the LF sequence has its greatest advantage when ventilation is absent or inadequate (10 cfm/T).

Forced ventilation has a further beneficial effect which may equal its benefit of faster pile cooling, and that advantage is the elimination of hot spots. Hot spots develop when convective air flow is restricted and when frozen cones develop and later thaw. Forced ventilation of 20 cfm/T will almost totally eliminate hot spot development by breaking up this normal convective pattern.

Since the Michigan condition showed the greatest advantage for forced ventilation, a more critical evaluation was made. The relationship between pile temperature after 20 days of storage, ventilation rate, and harvest date are given in Figure 1. Beets piled on October 10 and not ventilated would still be excessively warm after 20 days of storage. This is, in part, because of warm root temperatures at harvest and a lack of available cooling air. Even 20 cfm/T only reduced the mean pile temperature by $7^{\circ}F$ over the 20 days. The major advantages of delayed harvest appear to be the reduction in root temperature at piling time and the amount of cooling air available. Ventilation shows its greatest advantage after October 15. Camouflaged by the mean values presented is the excessively wide range in temperatures existing in the 0 cfm pile compared to the 20 cfm ventilated pile. Forced ventilation reduced the temperature differential between the top and bottom of the pile to only 3 degrees compared to 10 degrees for the non-ventilated pile.

Sucrose losses during the initial 20-day storage period followed the temperature curves very closely (Figure 2). Ventilation with 20 cfm provided a savings equivalent to delaying harvest from October 10 until October 30 and storing without ventilation.

Our conclusion from these preliminary studies is that ventilation can play a very important role in reducing storage losses; particularly in areas where ambient cooling air is marginal. The additional advantage of hot-spot elimination is equally as important as the benefit of rapid cooling. We have not included power and labor costs in these studies, and these are of obvious importance. These data also indicate that 20 cfm/T ventilation capacity is required. Capacities of 10 cfm/T are, in most cases, simply a waste of time and money.

Table 1. A comparison of sucrose loss in sugarbeet storage piles cooled by either free convection or forced ventilation. Also compared are the removal practices of first-in first-out and last-in first-out.

Venti lation Rate	Garland		Saginaw		Moorhead		Longmont		Moses Lake	
	FF[1/]	LF	FF	LF	FF	LF	FF	LF	FF	LF
cfm/Ton	Sucrose Loss - Lbs/Ton									
0	16.6	16.5	23.6	23.2	14.0	13.9	17.6	17.3	16.3	16.1
10	13.5	13.4	16.4	16.0	11.4	11.3	13.8	13.5	12.6	12.3
20	12.6	12.4	14.8	14.3	10.7	10.6	12.8	12.5	11.8	11.4
30	12.0	11.8	14.4	14.1	10.5	10.4	12.5	12.2	11.6	11.5

1/ FF - First-in first out; LF - Last-in first-out.

Piling was assumed to start on October 15 at all locations and was completed in two weeks. The average length of the storage period was 48 days.

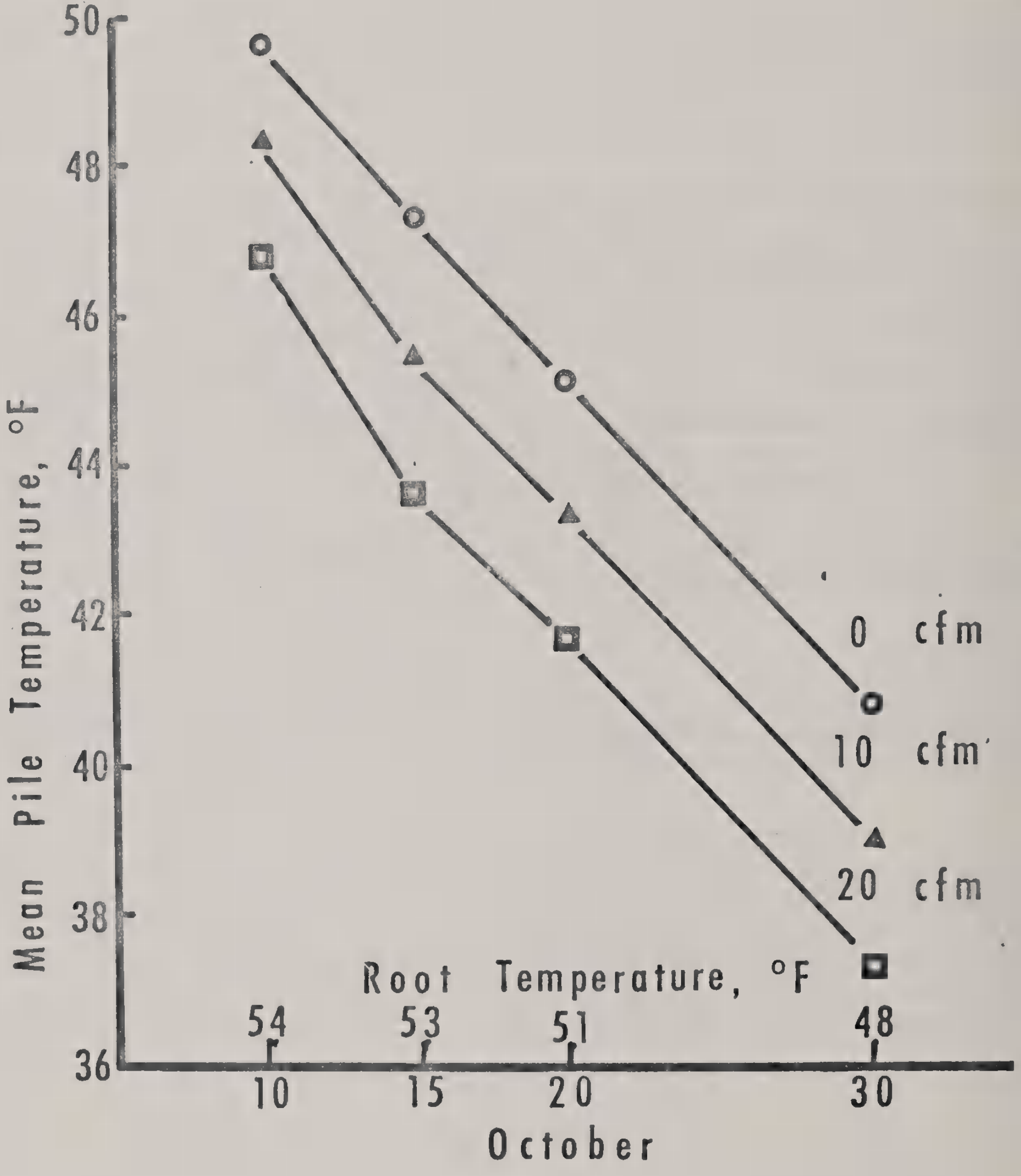

Figure 1. Relationship between ventilation rate, harvest date, and mean pile temperature after 20 days of storage at Saginaw, MI.

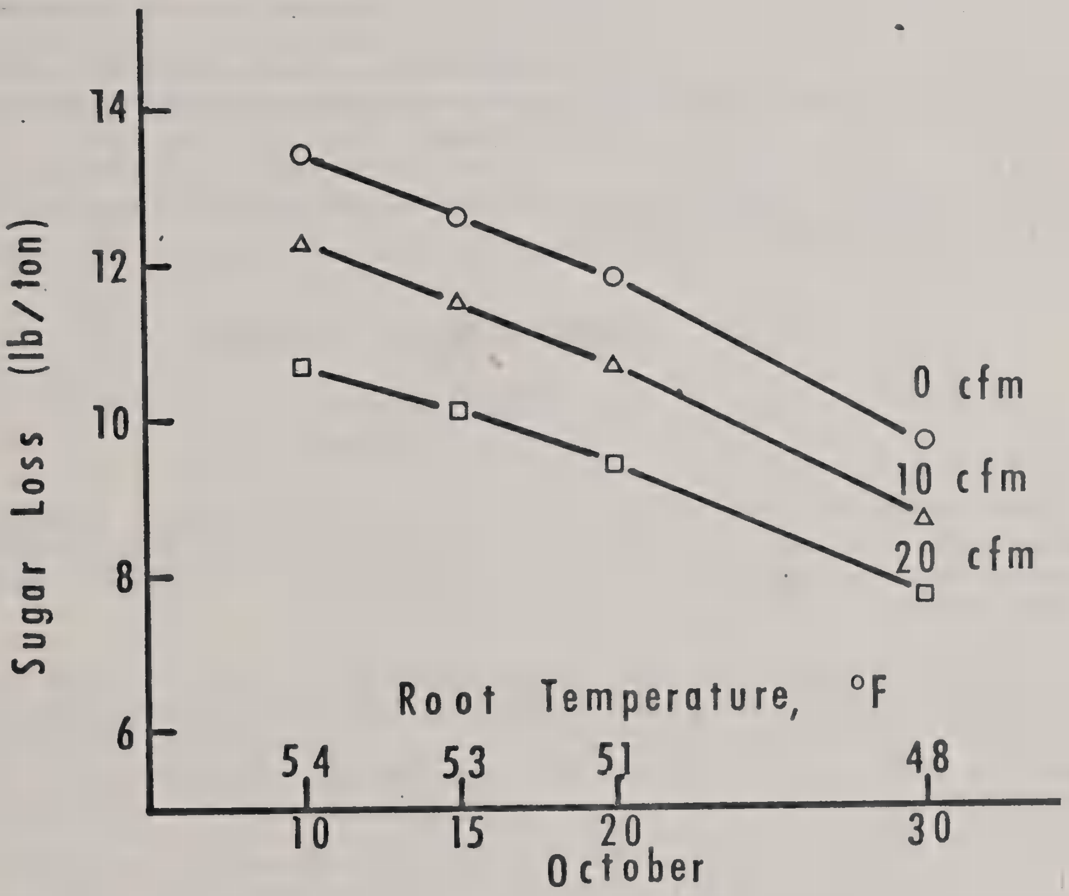

Figure 2, Relationship between ventilation rate, harvest date and sucrose loss during the first 20 days of storage at Saginaw, MI.

V. MALE STERILITY

MITOCHONDRIAL DNA MUTAGENS

D. L. Doney and J. C. Theurer

Ethidium bromide has been reported to be a mutagenic agent for mitochondrial DNA. Since the mitochondrial DNA is the genetic material believed to be responsible for cytoplasmic male sterility, several workers have tested it on crop plants. It has been reported to be effective in inducing cytoplasmic male sterility in sorghum and several grass species.

The past year we have been testing this chemical on sugarbeet as a means of inducing cytoplasmic male sterility. Results thus far are inconclusive. At high concentrations (1000 ppm), plants are killed, and at lower concentrations (250 ppm) little effect is observed. In a population of 250 plants treated with 1000 ppm for 24 hours, two plants were observed to be sterile. We were unable to obtain seed set on these plants. We, therefore, believe other important plant functions were affected. Two plants were observed to have what we believed to be mutations of the chloroplast DNA. We are currently testing other larger populations.

RESTORER HYBRIDS OF NORMAL vs STERILE CYTOPLASM

J. C. Theurer

In some crops, the type of cytoplasm that a pollen restorer carries influences production. A small field test was conducted at Logan, Utah, this year to compare four hybrids having L29Rf(N) cytoplasm with counterpart L29Rf(S) cytoplasm hybrids. Data are listed in tables 1 to 3.

In general, hybrids with L29Rf(N) cytoplasm were higher in yield and lower in sugar than L29Rf(S) cytoplasm hybrids. This, however, was mainly due to the significant difference of A7211 hybrids. L53 hybrids with L29Rf(S) plasm had slightly higher yield than the (N) cytoplasm counterpart hybrid. There was no significant difference in quality of hybrids with (N) vs (S) plasm.

Table 1. Means for yield, sugar percentage, and quality factors for four (N) cytoplasm vs (S) cytoplasm hybrids - Logan, Utah, 1977.

	Gross Sugar	Root Weight Tons/Ac.	% Sugar	PPM Amino N	PPM K	PPM Na	Index
A7211xL29(N)	7936	26.6	14.9	581	2115	120	773
L53xL29(S)	7357	23.9	15.4	665	1997	129	783
E2xL29(N)	7201	24.2	14.8	605	2032	111	776
L53xL29(N)	7125	23.6	15.1	661	1967	132	797
C1xL29(N)	6979	23.5	14.9	609	2000	118	775
A7211xL29(S)	6949	23.4	14.8	625	2317	142	874
C1xL29(S)	6942	22.7	15.3	622	1952	106	750
E2xL29(S)	6619	21.6	15.3	657	2192	137	822
F	2.92*	4.00**	1.42	1.87	2.59	1.63	1.37
LSD 0.05	655	2.05	0.56	64	232	28	74
CV	7.1%	6.7%	2.9%	7.9%	8.7%	17.6%	7.2%
Mean	7138	23.7	15.1	629	2069	125	790

Table 2. Means by female parent,

	Gross Sugar	Root Weight Tons/Ac.	% Sugar	PPM Amino N	PPM K	PPM Na	Index
A7211	7442	25.0	14.9	603	2216	131	808
L53	7241	23.8	15.3	663	1972	131	790
C1	6960	23.1	15.1	616	1976	112	762
E2	6910	22.9	15.1	631	2112	124	799
LSD 0.05	518	1.6	0.5	50*	183*	22	58

Table 3. Means normal vs sterile cytoplasm.

(N)	7310	24.5	14.9	614	2028	120	780
(S)	6967	22.9	15.2	642	2109	128	799
LSD 0.05	366	1.2*	0.3*	36	130	16	41

VI. SUGARBEET DISEASES

A METHOD OF EVALUATING SUGARBEET SEEDLINGS FOR RESISTANCE TO POWDERY MILDEW

D. L. Mumford

Powdery mildew became a serious disease of sugarbeets in the United States in 1974 and has continued to be a problem each year since that time. Although treatment with sulfur is very effective in controlling powdery mildew, the development of resistant cultivars is a desirable long-term control measure.

The reaction of sugarbeets to powdery mildew can be determined in field tests under conditions of natural infection. The disadvantages of field tests are that only a single evaluation can be made each year, the level of natural infection may be too low for effective evaluation, and a plot left uncontrolled for evaluation purposes provides abundant undesirable inoculum for adjacent commercial plantings. A seedling evaluation method would avoid these problems.

Although sugarbeet plants become more susceptible as they mature, young seedlings can be successfully inoculated. Procedures for uniformly inoculating young seedlings and indications that their reaction can be used to select for resistance are reported here.

The most important requirement for successful inoculation of seedlings is the availability of an abundant supply of recently produced conidia. Conidia were produced on a commercial cultivar (Mono HY D2). Every 3 or 4 days, several 2-month-old source plants were inoculated by shaking conidia onto them from heavily infected leaves. Eight to 10 days later, abundant fungus growth and sporulation were present on the inoculated leaves. In this way, inoculium source plants were available on a regular basis throughout the period of evaluation. When inoculum was needed, all conidia were blown off the source plants, using an air supply of 20 p.s.i. Forty-eight hours later, abundant conidia, all of which were less than 48 hours old, were collected from the source leaves. Source plants for production of conidia were kept in a growth chamber with a light cycle of 16 hours at 25C and a dark cycle of 8 hours at 20C. Relative humidity ranged from 45 to 55 percent except for an hour after watering when it would reach 80 percent.

Initially, conidia were removed from the source plants by washing them off the leaves with water containing 0.05 percent Tween 20. This was accomplished by repeatedly spraying the water over the leaf surface with a syringe and collecting the runoff until a high concentration of conidia was obtained. This conidial suspension was adjusted to 50,000 per ml, then atomized onto seedlings to be evaluated. Two major difficulties were encountered when inoculating by spraying with a conidial suspension. It was difficult to obtain a uniform distribution of conidia on the leaves, and when conidia were suspended in water, germination was reduced over 50 percent. Therefore, a method of inoculating with dry conidia was adopted.

Seedlings to be evaluated were grown in containers 8x12x3 inches deep. Two rows of eight seedlings were grown in each container. When the first-true-leaves were expanded (plants were about 30 days old), they were pinned in a horizontal position to 1x12-inch wooden laths placed along each side of the row of seedlings. With the leaves in a horizontal position, the containers

of seedlings were placed in an enclosed settling chamber for inoculation.

The settling chamber consisted of a plywood box 3 feet square and 4 feet high. The containers of seedlings were introduced through a door at the base of the chamber and positioned on the chamber floor. Conidia were shaken from leaves of inoculum source plants through an 8-inch hole in the top of the chamber. The air in the chamber was stirred before and after introduction of conidia by rapidly rotating a stiff cardboard sheet (4x15 inches) through the hole in the upper portion of the chamber. The conidia were allowed to settle onto the horizontal, first-true-leaves of the seedlings for a period of 5 minutes. Small agar disks on glass slides were positioned on the floor of the chamber to obtain a measure of the distribution and number of conidia settling on leaves during an inoculation. After inoculation, the pinned leaves were released and the containers of seedlings were placed in a growth chamber, having conditions as described above for source plants. Eight to 10 days after inoculation, the seedlings were rated on a scale of 0 to 5, based on the percentage of leaf area showing fungus growth and the relative intensity of sporulation. An evaluation was based on eight seedlings of each cultivar or breeding line.

Eight sugarbeet lines were evaluated on three different occasions to determine the repeatability of the method. Table 1 shows that the ranking of these eight lines for resistance to powdery mildew was consistent from one test to another.

Table 1. Rankings of eight sugarbeet lines evaluated for resistance to powdery mildew by the seedling method.

	Ranked according to resistance		
Line 1	Test 1	Test 2	Test 3
1	2	2	1
2	3	3	3
3	8	8	8
4	5	7	7
5	1	1	2
6	7	5	5
7	4	4	4
8	6	6	6

Eight sugarbeet lines were grown in a replicated test at Farmington, Utah, in 1976. The level of powdery mildew that developed from natural infection was adequate to rate the lines for resistance. Highly significant differences between lines were measured. These same eight lines were evaluated by the seedling method. The reaction of both cotyledons and first-true-leaves was determined. The reaction of first-true-leaves gave a higher correlation with field evaluation (r=0.8) than did the reaction of cotyledons (r=0.6). Therefore, first-true-leaves inoculated with dry conidia is the method being used in further tests to correlate the reaction to powdery mildew of seedlings in the growth chamber and greenhouse with mature plants in the field.

VII. INSECT RESISTANCE STUDIES

SELECTION FOR ROOT MAGGOT RESISTANCE

C. C. Blickenstaff, J. C. Theurer, and D. L. Doney

Selection and evaluation for resistance to the sugarbeet root maggot *Tetanops myopaeformis* were continued this year in a cooperative project between ARS personnel at Logan, Utah, and Kimberly, Idaho.

High-damage and low-damage roots were selected in the root maggot nursery at Kimberly in July 1976. Selfed and open-pollinated seed increases were made for these selections at Logan in early 1977. The selfed and open-pollinated progenies were planted at Kimberly on April 20, 1977. This was the third rating and selection from the heterogeneous population 25A1 and the second selection from a related population (25D47.48). Seed was planted by hand in 10-hill rows with hills 1 foot apart. Open-pollinated material was planted in 3-row plots and randomized in 20 replicates. Check entries (an inbred and a uniform hybrid) and the selfed-seed entries were planted in single rows in blocks of three entries with block locations randomized within main replicates and entries completely randomized. The number of replicates for the selfed entries varied from one to eight, depending upon the amount of seed available for planting.

Average plant height per row was recorded on June 9, 2 to 5 days after peak fly activity as measured by sticky stake traps. The plots showed curly top infection and were rated for this disease on July 7. All plants were hand-dug July 19 and 20, rated for maggot damage on a scale of 0 = none to 5 = severe damage, and high and low selections were made. These roots were washed, stored at 40F, and later transported to Logan for seed increase for the next cycle of selection.

Five lines not previously tested for maggot resistance were included as part of a test on inbreds and other material screened for the first time. They were planted by hand in 10-hill single-row plots and randomized in ten replicates. Hills were thinned to single plants. Average height was recorded June 10, a few days after peak fly activity. Stand counts were made on June 10, 17, and at harvest July 20. The number of plants with symptoms of curly top were recorded on June 17, 30, and July 7. Plants were hand-dug and rated for sugarbeet root maggot damage on July 20, using the same 0 to 5 scale cited above.

RESULTS

The root maggot damage ratings, plant height, and curly top readings are listed in Table 1. The root maggot infestation was more severe in 1977 than in 1976 as manifested by the slight increase in damage rating in 1977 (refer to 1976 Research Report, p. B73). The low-damage selections for population 25A2 were significantly lower than the original parent and the high-damage selections. High-damage selections were only slightly greater in maggot damage than the original parent. This might be expected since seed cannot be obtained from the most severely damaged plants. Thus, the selection pressure is not as great in this direction. The 25D47.48 population has about 50 percent of the same original lines used to develop the

25A1 population. When this population is compared with 25A1 parent, it also shows an indication that progress has been made in lowering the disease-damage rating by selection.

Table 2 summarizes these comparisons in respect to damage ratings as percentages of the parent population. Increase of 1976 low selection showed 14 percent less damage than the parent. Selfed lines from low-damage selections gave from 2 to 27 percent less than the parent, while high-damage selfed populations ranged from 3 percent lower to 11 percent higher than the parent.

Selections for low damage were slightly taller than selections for high damage. The correlation between maggot damage and plant height was 0.46.

The relationship between curly top and maggot ratings is not clear. However, those entries selected for low damage averaged 6.3 percent curly top and those selected for high damage averaged 10.1 percent. The correlation between the two was positive and significant, 0.75*.

Performance of five lines evaluated for root maggot and their resistance to curly top are given in Table 3. Two of the lines had poor germination and subsequent poor stand. Number 76514 had the lowest rating for maggot. Inbred 14C23 that exhibited no curly top at any reading is a new curly top inbred we propose to release in the near future.

Table 2. Performance of selections for root maggot in percent of the parent population.

1977 Progenies	Selected in 1976 for: Low Damage	High Damage
25A1 Self	89.0	103.2
25A1 Open Pollinated	86.4	102.9
Average	87.6	103.0
25D 47.48 Selfs	92.5	109.4
25D 47.48 Open Pollinated	86.7	97.4
Average	89.6	103.4

Table 3. Performance of inbred and O.P. lines for resistance to curly top and sugarbeet root maggot damage. Kimberly, Idaho, 1977.

	Avg. Hgt. 6/10	Stand 1/ 7/20	6/17	6/30	7/77	% Wilt 2/ 6/30	SBRM damage 3/ Rating 7/20-21
ARS76501	3.5	69	6.5	29.9	61.0	5.2	3.11 cd
ARS76502	2.7	68	1.4	2.9	7.2	1.4	3.05 cd
ARS76509	3.4	76	0.0	15.0	33.8	3.8	3.11 cd
ARS76511	1.7	20	10.0	15.0	35.0	0.0	2.67 abcd
ARS76514	3.0	23	0.0	0.0	8.3	0.0	2.54 abc
ARS14C23	3.0	80	0.0	0.0	0.0	3.6	2.97 bcd
L19ck (819)	2.8	52	7.7	15.4	23.1	3.8	3.26 d

1/ 10-hill plots x 10 reps. = 100 plants possible.

2/ Wilted plants supposedly due to root maggot stress.

3/ Means followed by the same letter do not differ significantly at the 5% level of probability using Duncan's Multiple Range Test.

SUGARBEET RESEARCH

1977 Report

Section C

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CONTENTS

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1977

HECKER, R. J. Recurrent and reciprocal recurrent selection in sugarbeet. Approved by ARS for publication in Crop Sci.

Five cycles of recurrent selection (RS) for general combining ability and two cycles of reciprocal recurrent selection (RRS) in sugarbeet (*Beta vulgaris* L.) were evaluated. The fifth cycle RS synthetic produced significantly less sucrose than its source population, but combined equally as well as its source population with a group of four male sterile tester lines. The reduced sucrose yield of this synthetic was entirely due to a reduction of root yield, which could be partially accounted for by the estimated 20% inbreeding of this synthetic.

Three second cycle RRS synthetics were produced from each of two source populations (A and B). These synthetics were generated on the basis of superior progeny performance for recoverable sucrose, root yield, and sucrose content, respectively. The second cycle synthetic for root yield from source A was the only one with increased recoverable sucrose, relative to its source. Root yield improvements were made in two synthetics from the low yield source A. Improvement in sucrose content was made in two synthetics derived from the lower sucrose source B. In no synthetic was there a simultaneous increase in root yield and sucrose content. Crosses between the A and B synthetics did not significantly exceed the performance of the superior source parent for recoverable sucrose or any of its components, root yield, sucrose content, or thin juice purity. Reciprocal recurrent selection was successful in improving the general and specific combining ability of those yield components which were relatively low in the sources. Simultaneous improvement of all components for production and for combining ability was not achieved by either of the two breeding methods.

HECKER, R. J. and E. G. RUPPEL. Effect of pesticides and nitrogen fertility on rhizoctonia root rot of sugarbeet. Accepted for publication in J. Amer. Soc. Sugar Beet Technol.

A root and crown rot of sugarbeet caused by the soil-borne fungus *Rhizoctonia solani* extracts a significant toll from U.S. beet growers each year. In order to assess the effect of contemporary pesticides and nitrogen fertility practices on root rot, experiments were conducted for 2 years at Fort Collins, Colorado. A widely used herbicide (cycloate; trade name 'Ro-Neet'), systemic insecticide (aldicarb; trade name 'Temik'), and nematocide (1,3-dichloropropene; trade name "Telon II") were shown to increase root rot to a slight but not practically important degree. Higher levels of nitrogen fertilization were shown to inhibit root rot in certain environments, but the inhibition was insufficient to be of practical value. Therefore, it was concluded that current pesticide and nitrogen fertilizer uses are neither enhancing nor inhibiting rhizoctonia root rot of sugarbeet.

MARTIN, S. S. Accumulation of the flavonoids betagarin and betavulgarin in Beta vulgaris infected by the fungus Cercospora beticola. Physiol. Plant Path. 11:297-303.

The flavanone betagarin and the isoflavone betavulgarin occur in necrotic lesions resulting from infection of sugarbeet (*Beta vulgaris*) leaves by

Cercospora beticola. In whole infected leaves from cultivars of varied leaf spot susceptibility, there were significant differences among cultivars in content of both flavonoids, but only betavulgarin content was significantly correlated with a visual rating of disease severity. In lesions, the content of both compounds differed significantly among cultivars, but only betavulgarin content differed with time after disease initiation. At 3 weeks after plants were inoculated with a suspension of fungal spores, lesion betagarin concentrations were 300 to 1050 µg/ml, depending on cultivar, and betavulgarin contents were from 50 to 200 µg/ml. When compared with data from *in vitro* bioassays, these amounts appear potentially capable of limiting fungal growth. However, the correlation coefficient between visual rating of disease severity and compound contents per lesion was non-significant for each flavonoid.

SMITH, G. A. and S. S. MARTIN. <u>Differential response of sugarbeet cultivars to Cercospora leaf spot disease</u>. Accepted for publication in Crop Sci., November-December 1977.

Preliminary observations and data on sugarbeet (*Beta vulgaris* L.) yield and quality components suggested that a possible differential response to infection by the fungus *Cercospora beticola* exists among sugarbeet cultivars and genotypes with different inherent levels of resistance and possibly among cultivars with similar resistance. The objectives of this study were: 1) to determine, for cultivars known to vary in leaf spot resistance, the effects of leaf spot disease on sucrose yield components and on extract chemical components which affect sugarbeet juice purity; and 2) to examine whether infected cultivars with similar resistance to leaf spot respond in similar or different ways. Eight sugarbeet cultivars ranging from leaf spot resistant to leaf spot susceptible were examined under an artificially induced leaf spot epidemic in a 2-year field study. With increasing severity of *C. beticola* infection there was a general increase in nonsucrose chemical components, and decrease in gross sucrose yield, yield components, and purity. Of the chemical components, sodium, nitrate, amino N, and total N consistently showed the greatest increases with increased infection by *C. beticola*. Numerous examples of differential response of the cultivars to *C. beticola* infection were found for nonsucrose chemical components as well as for sucrose yield and yield components.

<u>Published Papers Abstracted in Sugarbeet Research, 1976 Report</u>

HECKER, R. J. and E. G. RUPPEL. <u>Registration of diploid and tetraploid FC 701/4 and FC 703 sugarbeet germplasm</u>. Crop Sci. 17:678. 1977.

HECKER, R. J. and E. G. RUPPEL. <u>Rhizoctonia root-rot research in sugarbeet: breeding and related research</u>. J. Amer. Soc. Sugar Beet Technol. 19:246-256. 1977.

RUPPEL, E. G. and S. J. PETERSEN. <u>Effect of benomyl on in vitro and in vivo biology of benomyl-tolerant strains of Cercospora beticola</u>. J. Amer. Soc. Sugar Beet Technol. 19:233-239. 1977.

RUPPEL, E. G. and B. J. TOMASOVIC. <u>Epidemiological factors of sugar beet powdery mildew</u>. Phytopathology 67:619-621. 1977.

SMITH, G. A., S. S. MARTIN, and K. A. ASH. Path coefficient analysis of sugarbeet purity components. Crop Sci. 17:469-472. 1977.

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SMITH, G. A. and S. S. MARTIN. Recovering more dollars from sugarbeets. Agr. Research 26:11. 1977.

STEINKAMP, M. P. and L. L. HOEFERT. Annulate lamellae in phloem cells of virus-infected Sonchus plants. J. Cell Biol. 74:111-118. 1977.

BIOCHEMICAL, GENETIC, AND PATHOLOGICAL FACTORS INFLUENCING SUGARBEET QUALITY, YIELD COMPONENTS, AND DISEASE RESISTANCE (BSDF Project 25)

Comparison of Aluminum Chloride and Lead Subacetate Clarification of Sugarbeet Brei Extracts. II. Impurity components.--S. S. Martin and R. J. Hecker.

Impurity components were measured in paired samples clarified by aluminum chloride (1.0 g anhydrous salt per liter) or by the standard lead procedure. Eighty samples of each type were obtained from field-grown plants of 8 experimental hybrids. Sample preparation was identical for each pair except for the clarifying solution added. Sodium and potassium were analyzed by flame photometry with a lithium internal standard, amino N was determined spectrophotometrically with ninhydrin, total N was measured spectrophotometrically by direct Nesslerization of acid-digested samples, and nitrate was determined by specific ion electrode. Data are in mg/100 ml; expression as mg/100 g sucrose would not appreciably alter the results.

For sodium, potassium, and amino N, the clarified filtrate components of greatest interest relative to beet quality, correlation coefficients between aluminum- and lead-clarified samples were 0.87 or above (Table 1). There was excellent correlation and no significant difference by paired-sample t-test between extract types for sodium. The mean potassium content was slightly lower in the aluminum filtrates than in the lead filtrate samples, and the correlation coefficient between the two sample types also suggests slight discrepancy between extracts. Nevertheless, either extract is probably satisfactory for normal purposes of potassium evaluation in clarified filtrates. For amino N, slightly higher values in aluminum-clarified samples than leaded ones are reflected in the means, and significant difference was shown by paired t-test. The correlation coefficient between sample types, however, was reasonably high ($r=0.932$). Burba and Puscz (Z. Zuckerind. 26:249-251, 1976) found no significant difference between lead- and aluminum-clarified filtrates for either potassium or amino N. Although the sugarbeets that were the source of our samples were of lower sucrose and quality than those analyzed by Burba and Puscz, we cannot positively identify the sources of variation leading to the extract differences we observed. We are also determining amino N in the two sample types by fluorescence spectroscopy with o-phthalaldehyde reagent, but those data are not yet available.

Pol sucrose in the two extract types was previously reported not to differ significantly (Sugarbeet Research, 1976 report, p. C-14). The summary of those data is shown in Table 1.

Table 1. Comparison of chemical constituents in aluminum- vs. lead-clarified sugarbeet brei extracts.

Analysis	Correl. coeff. r	---------Mean[1]---------- Pb filtrate	Al filtrate	Paired-sample t
Sodium	0.957	7.44	7.45	1.31 ns
Potassium	0.878	17.36	17.15	3.14**
Nitrate	0.977	7.46	10.06	21.51**
[Nitrate, transformed]	0.977	7.46	7.46	0.021 ns
Amino N	0.932	3.23	3.86	10.41**
Total N	0.657	18.49	16.25	7.75**
Sucrose, pol.	0.987	14.41	14.39	0.80 ns

[1]Means are in mg/100 ml of extract except pol sucrose in percent of sugarbeet fresh weight. Amino N is expressed as glutamic acid, total N as N, and nitrate as NO_3^-.

Because the chloride ion is known to interfere with the nitrate specific ion electrode, the aluminum-clarified solutions were expected to and did show higher values for nitrate content than did the leaded filtrates. Somewhat unexpected, however, was the high correlation coefficient between the two extract types (r=0.977), suggesting that the interference was essentially linear over the sample nitrate concentration range. Consequently, we transformed nitrate values by subtracting from each original nitrate value in the aluminum filtrates the difference between the aluminum-extract mean and the lead-extract mean [transformed $NO^-_{3(Al)}$ = original $NO^-_{3(Al)}$ - 2.60]. This transformation does not alter the correlation coefficient or the slope of the relationship between the two sets of data, but yields data sets with identical means. Thus, comparison of the transformed aluminum-filtrate nitrate data with the lead-filtrate data gave identical means, correlation coefficient r=0.977, and a non-significant paired-sample t-test (t=0.021). It is somewhat surprising that a linear correction is satisfactory at this low nitrate concentration, but in this experiment the average deviation between paired samples (lead-filtrate data vs. transformed aluminum-filtrate data) was only 0.0025. Another aluminum salt could be used that would be expected to show less interference with the nitrate electrode (e.g., aluminum sulfate; the selectivity coefficient for sulfate is lower than that for chloride), but aluminum chloride may be preferable from a waste disposal viewpoint. Therefore, if a simple empirical relationship exists between apparent nitrate content of the aluminum chloride clarified solution and nitrate content in leaded filtrate, it may remain advantageous to use the chloride salt. Also, we are currently examining the interference of chloride to the nitrate ion-selective coated wire electrode, and the potential use of this simple and inexpensive electrode in sugarbeet nitrate determinations.

The correlation coefficient between the two extract types for total nitrogen content was moderate (r=0.657, Table 1). The significant paired-sample t-test and moderate difference in extract means further indicate the differences that exist between extract types for this analysis. It is not clear, however, just what meaning total N analysis has in leaded filtrates, as it is usually poorly correlated with total N in raw juice or laboratory thin juice. Thus, a sucrose filtrate, whether clarified by aluminum chloride or by lead subacetate, probably cannot yield any useful measure of total N.

To further clarify some of the observations made in this trial, we are now conducting a larger experiment in which raw juice, laboratory thin juice, lead-clarified, and aluminum-clarified matched samples will be compared. To provide a test across a wide variety of conditions, the experiment will include two levels of nitrogen fertility, and sugarbeet cultivars ranging from a low-sucrose, low-purity type to a high-sucrose type.

The Relationships of Different Purities and Their Components.--R. J. Hecker and S. S. Martin.

Since the development of the laboratory thin juice method by Brown and Serro (Proc. Amer. Soc. Sugar Beet Technol. 8:274-278, 1954) and its modification by Carruthers and Oldfield (Int. Sugar J. 63:72-74, 1961), this laboratory method has been more-or-less accepted as the standard for measurement of purity. The relationship of the purity of this laboratory thin juice and the factory second carbonation juice was very close according to Carruthers and Oldfield (1961). However, comparisons in other environments and on an extensive scale have not been reported.

There are other juices for which purities can be determined and other methods of determination of the purity components. The objective of this experiment was to compare purities determined by other methods and establish relationships among these purities.

A randomized complete block experiment was grown under disease-free conditions at Fort Collins, Colorado, with relatively abundant available nitrogen. The three entries described in Table 1 were planted in two-row plots with 20 replications. The variables are described in Table 2. The raw juices were hand-pressed through four thicknesses of cheese cloth. The standard laboratory method was used to produce the thin juice. The oven dry weights of raw juice and thin juice were measured by drying the juices to constant weight on sand. The five measures of purity were described in Table 2 (C3, C5, C8, C11, and C14). The means for these purities and their respective components are shown in Table 3 along with their CV's and standard deviations. The raw juice purities (C3 and C14) are not significantly different. The dry weight raw juice purity (C5) at 79.2% appears to reflect the effect of the marc present in the raw juice. The difference between the standard thin juice purity (C11) and the dry weight thin juice purity (C8), 92.6 versus 86.7, does not have an immediately apparent explanation, since essentially all insoluble solids should have been removed in the thin juice process. The sucrose components of these

two purities, C6 and C10, are not directly comparable, but previous experience would indicate that these two measures of sucrose are likely to be very similar. Therefore, the difference in the purities (C8 and C11) appears to have arisen from the difference between thin juice RDS and thin juice dry weight (C9 and C7).

Table 1. Populations used for purity comparisons.

Entry	Population
1392	GW Mono Hy A1; commercial hybrid; medium sucrose and dry matter
1393	52-305 CMS X Ovana, F_1; sugarbeet X fodder beet hybrid; low sucrose and dry matter
1394	67MSH154 (CMS) X Polish 203/71; experimental hybrid; high sucrose and dry matter

Table 2. Description of variables.

C1	Raw juice gas chromatographic sucrose (% of raw juice)
C2	Raw juice refractive dry substance (% of raw juice)
C3	Raw juice purity % (RJGC Suc/RJRDS, expressed as %)
C4	Raw juice dry weight (g oven dry weight of RJ/100 ml RJ)
C5	Dry weight raw juice purity (RJGC Suc/RJ dry wt, as %)
C6	Thin juice GC sucrose (% of thin juice)
C7	Thin juice dry weight (g oven dry wt of TJ/100 ml TJ)
C8	Dry weight thin juice purity (TJGC Suc/TJ dry wt, as %)
C9	Thin juice refractive dry substance (% of TJ)
C10	Thin juice polarization (Standard pol reading of TJ)
C11	Thin juice purity (standard)
C12	Brei pol sucrose (standard)
C13	Root weight (kg/plot)
C14	Leaded raw juice purity (brei pol suc/RJRDS, as %)

The CV's in Table 3 show the relative variability of each of the purities and its components. It can be seen from these statistics that thin juice purity (C11) was the least variable followed by raw juice purity (C3), and leaded raw juice purity (C14), with the dry weight purities (C5 and C8) having the greatest variability. A look at the components of these purities indicates that for raw juice purity (C3), leaded raw juice purity (C14), and thin juice purity (C11), the greatest variability was exhibited by the sucrose measure and the least by the measure of total solids. In the case of the dry weight purities (C5 and C8), the greatest variability was associated with the dry weight or total solids measurements.

Table 3. Means, coefficients of variability, and standard deviations across entries.

Variable	Mean	CV	s	95% of samples
RJ Pur C3	85.5	2.65	2.19	81.1-89.9
RJGC Suc C1	15.7	4.20	.66	14.4-17.0
RJ RDS C2	18.3	3.62	.66	17.0-19.6
Pb RJ Pur C14	86.5	3.17	2.74	81.1-92.0
Brei Pol Suc C12	15.9	3.62	.58	14.7-17.1
RJ RDS C2	18.3	3.62	.66	17.0-19.6
Dry wt RJ Pur C5	79.2	3.49	2.77	73.7-84.8
RJGC Suc C1	15.7	4.20	.66	14.4-17.0
RJ Dry wt C4	19.8	5.15	1.02	17.7-21.8
TJ Pur C11	92.6	1.92	1.78	89.0-96.1
TJ Pol C10	43.6	5.44	2.37	38.8-48.3
TJ RDS C9	11.7	4.77	.56	10.5-12.8
Dry wt TJ Pur C8	86.7	3.92	3.40	79.9-93.5
TJGC Suc C6	10.6	5.15	.55	9.5-11.7
TJ Dry wt C7	12.2	6.74	.82	10.6-13.9

Since one of the objectives of this experiment was to look at a range of genotypes, these individual entry means and CV's are shown in Table 4. The differences in means among these entries were about as expected with respect to sucrose and solids measures. Entry 1393, was the sugarbeet X fodder beet hybrid, was more variable for all characters, with one exception, than the two sugarbeet entries. This was probably due to the greater genetic variability in this entry and possibly the environmental interactions which did not exist in the sugarbeet entries. Between the two sugarbeet entries (1392 and 1394) there were no patterns of differences in variability.

From the CV's in Tables 3 and 4, it was expected that correlations between the different purities would not be close. This is shown in Table 5 where the correlations across entries, although all highly significant, were not very high. Correlation of thin juice purity (C11) with raw juice (C3) and leaded raw juice (C14) purities was 0.61 and 0.58, respectively. The highest correlation of all was raw juice purity (C3) with leaded raw juice purity (C14) at 0.71. In another experiment involving eight experimental hybrids, we found the latter correlation to be 0.52 and thin juice purity correlations with raw juice and leaded raw juice purity to be 0.55 and 0.47, respectively. The within-entry correlations among these five purities are shown in Table 6. Correlations in this case are generally weaker, and it is apparent that the range of the three entries contributes somewhat to the stronger correlations in Table 5.

Table 4. Means and CV's of individual entries.

Variable	Means			CV's			s		
	Entry			Entry			Entry		
	1392	1393	1394	1392	1393	1394	1392	1393	1394
RJ Pur C3	85.936	83.208	87.424	2.3	3.5	1.6	1.99	2.90	1.41
RJGC Suc C1	16.349	12.916	17.851	3.7	5.0	4.1	.612	.640	.724
RJ RDS C2	19.003	15.518	20.413	3.2	4.2	3.5	.604	.659	.718
Pb RJ Pur C14	87.678	82.943	88.995	2.4	4.3	2.5	2.14	3.60	2.24
Brei Pol Suc C12	16.664	12.870	18.169	2.7	4.9	3.5	.443	.637	.628
RJ RDS C2	19.003	15.518	20.413	3.2	4.2	3.5	.604	.659	.718
Dry wt RJ pur C5	79.789	78.005	79.910	3.4	4.7	2.0	2.68	3.65	1.57
RJ GC Suc C1	16.349	12.916	17.851	3.7	5.0	4.1	.612	.640	.724
RJ Dry wt C4	20.479	16.579	22.222	4.0	6.1	5.4	.827	1.01	1.19
TJ Pur C11	93.560	90.707	93.392	1.3	2.8	1.4	1.17	2.52	1.33
TJ Pol C10	44.915	36.347	49.390	4.7	7.2	4.8	2.09	2.60	2.38
TJ RDS C9	11.939	9.976	13.090	4.3	6.2	4.1	.514	.619	.532
Dry wt TJ Pur C8	87.835	84.709	87.428	4.5	4.4	2.5	3.95	3.75	2.21
TJ GC Suc C6	10.947	8.778	12.063	4.8	6.6	4.4	.527	.576	.534
TJ Dry wt C7	12.479	10.379	13.803	6.5	8.8	5.4	.809	.913	.740

Table 5. Correlations among purities.

	RJ Pur C3	Pb RJ Pur C14	Dry wt RJ Pur C5	TJ Pur C11
Pb RJ Pur C14	.71**			
Dry wt RJ Pur C5	.66**	.44**		
TJ Pur C11	.61**	.58**	.43**	
Dry wt TJ Pur C8	.34**	.32**	.38**	.38**

It would appear from this experiment and others we have conducted in the recent past, that the correlations of thin juice purity and raw juice purity of commercial sugarbeet varieties are generally in the range of 0.5 to 0.6. This relatively low relationship is primarily due to the inherent variability in our measurement of the purity components. We would assume that the accuracy of our sampling, sample processing, and instrumentation is at least equal to any other lab handling a large quantity of samples; hence, any quality analysis laboratory in the industry that wants to improve their correlations of raw juice and thin juice purity will have to review every step of their

sucrose and total solids determination process, their sampling, and other steps, with the objective of reducing variability in these determinations. Our data here indicate that sucrose measurement is likely to be more variable than the total solids measurement. In any lab a study of the relative variability of the sucrose and solids determinations should provide evidence of where improvements of the laboratory methods might be made.

Table 6. Correlations among purities within entries.

	RJ Pur C3	Pb RJ Pur C14	Dry wt. RJ Pur C5	TJ Pur C11
Pb RJ Pur C14				
Entry 1392	.38*			
Entry 1393	.69**			
Entry 1394	.59**			
Dry wt RJ Pur C5				
Entry 1392	.69**	.25		
Entry 1393	.69**	.46**		
Entry 1394	.47**	.40*		
TJ Pur C11				
Entry 1392	.52**	.42**	.42**	
Entry 1393	.48**	.41*	.34*	
Entry 1394	.50**	.27	.35*	
Dry wt TJ Pur C8				
Entry 1392	.15	.03	.40*	.36*
Entry 1393	.22	.27	.31	.29
Entry 1394	.36*	.06	.26	.44**

<u>Leaf Spot Evaluations of Sugarbeet Lines Submitted by BSDF-Member Companies.</u> -- E. G. Ruppel and G. A. Smith.

Separate randomized complete block designs with two replications were used to evaluate a total of 155 breeding lines submitted by American Crystal, Great Western, Holly, and Spreckels Sugar companies. Internal checks included leaf spot-resistant cultivar FC (504 X 502/2) X SP 6322-0, a susceptible synthetic, and cultivar SP 5822-0 having intermediate resistance. The nursery was planted April 25 and inoculated on July 6. The epidemic developed slowly but uniformly, and reached maximum severity in early September. Leaf spot ratings on a scale of 0 to 10 were taken August 29 and September 7. Ratings for the resistant check across all tests ranged from 2.5-4.5 (mean of September rating = 3.4), whereas susceptible checks ranged from 5.0-8.5 (mean of September rating = 7.8). Results of the tests were tabulated and sent to each respective contributor.

Breeding for Leaf Spot and Curly Top Resistance, 1977.--G. A. Smith and E. G. Ruppel.

Table 1 presents the leaf spot and/or curly top ratings for some of our breeding lines as evaluated at Fort Collins, Colorado, and Logan, Utah, in 1977. The *Cercospora* epidemic in our 1977 nursery was very severe, perhaps as severe as we have seen since 1969. The curly top epidemic at Logan for 1977 was moderate and about the same as 1976. As emphasized in the 1976 Blue Book report, combining high levels of resistance to both leaf spot and curly top has been exceedingly slow. However, several 3-way crosses synthesized from monogerm parental lines developed at Fort Collins have shown good combined resistance. Entry numbers 1424, 1425, and 1432 are 3-way crosses which have shown good combined levels of resistance. Again in 1977, as in the previous 2 years of testing, these lines were equal to or better than the resistant checks for both diseases. Because the three parental lines of these three entries each occur as both CMS and type O, synthesis of a type O and its CMS equivalent for each of the entries is possible. The type O and CMS equivalent of entry 1424 has been synthesized and planted in Oregon for 1978 increase. If seed-producing capabilities are adequate the entry will be released. Work on synthesis of type O and CMS equivalents of entries 1425 and 1432 is proceeding. Several other entries with good levels of resistance to one or both diseases may be noted in Table 1. However, they have not been tested extensively enough to firmly establish their worth.

Table 1. Mean leaf spot and curly top ratings of some breeding lines tested at Fort Collins and/or Logan, Utah, 1977.

Entry no.	Seed no.	Description	Leaf spot[1]	Curly top[1]
1372	761016H2	FC 604 CMS, T.O., LSR-CTR X 741026H	6.5	4.0
1373	761016H	Intercross high sucrose X high LSR selections	6.5	5.5
1374	761017	Intercross high LSR X high sucrose selections	6.4	5.0
1375	761018HO2	FC 605 CMS,mm X L-35,CTR,T.O.,mm	7.0	
1376	761018HO3	FC 604 CMS,mm X L-35,CTR.T.O.,mm	7.8	
1377	761029H2	[(FC 504 CMS X FC 502/2) X FC 605] X 741026H	3.8	4.5
1378	761029H3	(FC 506 CMS X FC 605) X 741026H	5.5	4.0
1379	761029H4	FC 605 CMS X 741026H	4.6	3.5
1380	761029H5	(701212HO2 X FC 605) X 741026H	6.3	3.5
1381	761029H6	(FC 605 CMS X L-35) X 741026H	6.5	3.0
1382	761029H7	(701212HO3 X L-35) X 741026H	7.0	3.0
1383	761029H8	(701212HO2 X L-35) X 741026H	7.1	3.0
1384	761029H9	(FC 506 CMS X L-35) X 741026H	6.9	4.0
1385	761029H10	[(701212HO3 CMS X 662119s1) X FC 605] X 741026H	6.0	4.0
1386	761030H2	[FC(504 X 502/2) X FC 605] CMS X 741026H2	4.9	4.0
1387	761030H3	(FC 506 X FC 605) CMS X 741026H2	5.3	4.5
1388	761030H4	FC 605 CMS X 741026H2	5.9	4.0

Table 1. Mean leaf spot and curly top ratings...... (continued).

Entry no.	Seed no.	Description	Leaf spot[1]	Curly top[1]
1389	761030H5	[(662016s1 X 662119s1) X FC 605] CMS X 741026H2	6.1	3.5
1390	761030H6	(FC 605 X L-35) CMS X 741026H2	6.9	2.5
1391	761030H7	[(642027s1 X 662119s1) X L-35] CMS X 741026H2	6.8	3.0
1392	761030H8	[(622016s1 X 662119s1) X L-35] CMS X 741026H2	6.9	4.0
1393	761030H9	(FC 506 X L-35) CMS X 741026H2	6.6	3.5
1394	761030H10	[(701212H03 CMS X 662119s1) X FC 605] X 742026H2	6.1	3.5
1395	761031H02	[FC(504 X 502/2) X FC 605] CMS X L-35	7.0	2.0
1396	761031H03	(FC 506 X FC 605) CMS X L-35	6.9	3.0
1397	761031H04	FC 506 CMS X L-35	6.8	3.5
1398	761031H05	[(701212H03 CMS X 662119s1) X FC 605] X L-35	6.9	1.5
1399	761032H02	(701212H03 X L-35) X FC 601/2	3.1	2.0
1400	761033H02	(FC 506 CMS X L-35) X 741023	7.0	5.0
1401	761034H2	FC 605 CMS X 741024	6.6	
1402	761034H3	(FC 605 X 701212H02) X 741024	5.3	
1403	761034H	741024	7.0	
1404	761035H2	FC 605 CMS X 741025H	5.9	
1405	761035H3	(701212H02 CMS X FC 605) X 741025H	5.5	
1406	761035H	741025H	6.4	
1407	761036H02	FC 601 CMS X 751030	3.8	
1408	761036H03	FC 602 CMS X 751030	5.5	
1409	761036H04	FC 603 CMS X 751030	5.8	
1410	761036H05	FC 605 CMS X 751030	4.5	3.5
1411	761036H06	(FC 506 CMS X FC 605) X 751030	6.0	3.5
1412	761036H07	FC 506 CMS X 751030	4.5	
1413	761036H0	751030	5.5	3.5
1414	761039H02	FC 605 CMS X [(FC 504 X FC 502/2) X SP 6322-0]	3.6	4.5
1415	761045H	741026H = intercross of high sucrose X high LSR	6.1	4.5
1416	761045H2	741026H = intercross of high sucrose X high CSR	6.6	5.0
1417	761046H2	741026H2 = intercross of high LSR X high sucrose	6.8	4.5
1418	761046H	741026H2 = intercross of high LSR X high sucrose	6.5	4.5
1419	761047H2	741023 = intercross of high sucrose X high LSR	6.1	
1420	761047H	741023 = intercross of high sucrose X high LSR	5.9	5.5
1421	761048	741024 = high LSR sel. from RR lines X high sucrose	7.0	6.0
1422	761049H2	High sucrose (FC 605 CMS X FC 701/2 sel) X 741025H2	5.8	5.5

Table 1. Mean leaf spot and curly top ratings...... (continued).

Entry no.	Seed no.	Description	Leaf spot[1]	Curly top[1]
1423	761049H	751025H2 = high root wt and sucrose sel FC 701/2 X FC 605 CMS	5.5	5.5
1424	751102H02	(652016s1 CMS X 662119s1) X FC 605	5.5	2.5
1425	751102H04 or 751120H02	F_1, FC(504 X 502/2)CMS X FC 605 T.O.	5.1	4.0
1426	751102H03	(642027s1 CMS X 662119s1 T.O.) X FC 605	3.6	
1427	751102H05	FC 506 CMS X FC 605 T.O.	3.5	
1428	751103H03	(652016s1 CMS X 662119s1) X 731037HO	4.1	
1429	751105H02	(652016s1 CMS X 662119s1) X FC 506	5.5	
1430	751119H3	FC 605 CMS X LSR sels from *B. vulgaris* X *B. maritima*	5.1	
1431	751120H03	642027s1 CMS X (FC 601 X FC 605)	5.1	
1432	751124H02	[F_1, FC(504 X 502/2) CMS] X 662119s1	4.8	3.5
Checks				
1433	761042H02	FC(504 X 502/2)CMS X SP 6322-0, LSR check	4.6	
1434	731083	LSS check, synthetic check	7.5	
1435	661201HO	ILSR check, SP 6322-0 (variety D)	4.9	
	US 41			4.8
	US 33			5.6
	LSD at .05 level		1.12	1.13

[1]Leaf spot and curly top ratings based on 0-10 scale with 0 = no symptoms and 10 = death for curly top or complete defoliation for leaf spot.

Components of Sucrose Yield and Quality as Influenced by Ploidy Level.--
G. A. Smith and R. J. Hecker.

The use of diploids (2n = 2X = 18) in the U.S. has been fostered by the availability of diploid monogerm lines with good combining ability, adequate disease resistance, cytoplasmic male sterility, good seed production, and by lack of convincing evidence for superiority of polyploids. On the other hand, European sugarbeet breeders have maintained that polyploids, anisoploid and triploid, are superior to diploids. Theoretically this superiority, as in other crops, likely depends on the premise that polyploidy allows the accumulation of larger numbers of genes conditioning yield, and that a higher degree of heterozygosity is attainable through maximum utilization of available allelic variability. Of course, a common concern about polyploid sugarbeet varieties is the presence of aneuploidy which causes lower seed viability due to aneuploid mortality and embryo abortion.

We have previously used path coefficient analysis to study the components of yield and quality in diploid sugarbeets. The information presented here is part of a study designed to determine if the components of sucrose yield and juice are the same in 2X, 3X, and 4X sugarbeets and to determine if the relative order of importance of the components is similar at the three ploidy levels.

Two sets of populations were utilized in two experiments to achieve the objectives. In the first experiment we used 5 tetraploid (4X) lines, 13 triploid (3X) hybrids and 23 diploid (2X) lines and hybrids. Since only a few of the 2X and 3X hybrids can be considered as equivalents, entries of this experiment are referred to as "non-equivalents" 2X, 3X, and 4X entries. These non-equivalent entries of experiment 1 were grown in 1975 and 1976 in a randomized block design with 22 and 12 replications, respectively.

In the second experiment, 8 highly inbred 2X lines were converted to the 4X condition. The 2X and 4X equivalents were used to synthesize sets of 12 equivalent 2X, reciprocal 3X, and 4X hybrids. The reciprocal 3X hybrids, 4X♀ X 2X♂ and 2X♀ X 4X♂ are hereafter designated 3X(4X♀) and 3X(4X♂). The 2X, 3X, and 4X hybrids of this experiment are designated equivalent hybrids throughout this report. These equivalent hybrids were planted at Fort Collins in 1967 in a randomized block with six replications.

Root weight and sucrose were determined for both experiments. In addition raw pressed juice from experiment 1 and laboratory thin juice from experiment 2 was obtained for each plot row. For experiment 1, Na, K, nitrate N, amino N, chloride, total N, ash, and betaine were determined. For experiment 2, Na, K, and total N were determined. Analyses of variance, correlation and path coefficient analysis were used to examine the data.

Results. The 3X hybrids from the non-equivalent group had significantly higher sucrose % than the 2X hybrids. Purity of the 2X hybrids was consistently greater than 3X or 4X hybrids although not significantly so when compared as groups. In addition, 3X hybrids as a group were slightly greater than 4X entries for juice purity. The reduced purity with increasing ploidy level was universally accompanied by increased levels of the non-sucrose chemical components in both the equivalent and non-equivalent groups. For recoverable sucrose 53% of the non-equivalent 3X hybrids exceeded the 2 year test mean while 44% of the equivalent 3X hybrids exceeded their test mean. For the 2X non-equivalent and equivalent groups 52% and 67% of the entries exceeded the test means for recoverable sucrose, respectively.

Of particular interest was the consistently higher mean performance of the 3X(4X♀) hybrids as compared to the reciprocal 3X(4X♂) hybrids. Recoverable sucrose, root weight, sucrose %, and purity % were all greater in the 3X(4X♀) hybrid group. In addition, the 3X(4X♀) hybrids were also lower in K (16%), Na (9%), and total N (11%) than their equivalent 3X(4X♂) hybrids. In the equivalent hybrid group 60% of the 3X(4X♀) hybrids exceeded the test mean for recoverable sucrose, compared to 17% of the reciprocal 3X(4X♂) hybrids.

Path coefficient analyses demonstrated that the relative order of importance for the components of recoverable sucrose was generally the same for all three ploidy levels with root weight having the largest direct effect and purity the least. In past studies with 2X cultivars, we found that sucrose had a larger direct effect on recoverable sucrose than did purity. Similar results occurred in this study for the 2X non-equivalent entries but not for the 2X equivalent hybrids. Path coefficients for sucrose and purity, indicated that purity was over twice as important as sucrose in its effects on recoverable sugar for the 2X equivalent hybrid group. This difference between the 2X equivalent and non-equivalent groups may be attributed to their

respective breeding histories. The 2X equivalent hybrids were developed by crossing highly inbred lines which were essentially a random set of lines. Whereas, the 2X non-equivalent entries were diploid cultivars and not F_1 hybrids developed from random inbreds.

Path coefficient analyses of the non-sucrose chemical characters revealed that Na and amino N were the most important variables affecting purity in the 2X and 3X non-equivalent groups. Since only three non-sucrose chemical characters were determined for the equivalent hybrid group, it is not possible to say specifically that one of them is the most important character affecting purity. However, the high path coefficients for total N suggests that one or more of the nitrogeneous characters such as nitrate N, amino N, or betaine were greatly affecting juice purity. Large differences were found between the path coefficients of the 3X(4X♀) and 3X(4X♂) hybrids for Na. This indicates that Na had a much greater direct effect on purity in the 3X(4X♀) hybrids than in their reciprocals even though the quantity of Na in the 3X(4X♀) hybrids was less than in the 3X(4X♂) hybrids.

The consistent and often significant differences between 3X(4X♀) hybrids and their reciprocal 3X(4X♂) equivalents is particularly noteworthy in light of recent reports by other investigators. Bosemark citing data of Fitzgerald and Lahousse reported a 6% difference in sugar yield in favor of triploid seed harvested off of 3X(4X♀) plants. We found average differences of 11% for root weight, 4% for sucrose % and 15% for recoverable sucrose yield in favor of the 3X(4X♀) hybrids. Expansion of this report is being submitted for publication.

<u>Experimental Hybrids Involving Rhizoctonia Resistance Pollinators</u>.--R. J. Hecker and G. A. Smith.

Rhizoctonia resistant sugarbeet lines developed from the rhizoctonia resistance breeding program have until now been primarily multigerm material. We have crossed a number of these lines with a series of experimental and commercial monogerm male sterile lines. The resulting experimental hybrids are used as preliminary assessments of the combining ability of the resistant pollinators. In 1977, we evaluated 98 such hybrids under diesase-free conditions in a 10 X 10 triple lattice (six reps) at Fort Collins. Table 1 lists the most superior of these experimental hybrids.

Only four of the experimental hybrids were not significantly different than the check (Mono Hy D2). The balance of the hybrids in Table 1 had significantly less recoverable sucrose than the commercial check variety. Nonetheless, it appears that several of the hybrids might merit further testing for potential use in production areas where rhizoctonia root rot is a common problem. Some of the pollinators would be worth testing on a wider array of monogerm male steriles with the possibility of developing a hybrid with high specific combining ability. Among the pollinators in this study, general combining ability rank was (best to worst) as follows: FC 703 Syn, F1002 (Phoma selection from FC 701/4), FC 701/5 Syn, (FC 702/5 X FC 701/5, F_2) Syn, FC 702/5, FC 801 Syn, Syn of diverse Rhzoctonia lines, and Syn of miscellaneous sources. The majority of these pollinators have been officially released or are currently in the process of release.

Table 1. The most superior experimental hybrids in the 1977 test of hybrids involving rhizoctonia resistant pollinators.

Entry no.	Hybrid	Recov. sucrose (lbs/A)	Root yield (T/A)	Sucrose (%)	T. J. purity (%)
842	E 929 CMS X F1002	7349	31.4	14.5	90.5
843	H65-02-69 CMS X F1002	7032	31.0	14.2	90.2
809	(562 CMS X 569) X FC 703	6916	33.2	13.3	89.4
819	FC 603 CMS X FC 703 Syn	6859	32.4	13.6	89.4
803	FC 603 CMS X FC 701/5 Syn	6830	31.8	13.6	89.3
860	(FC 504 CMS X FC 502/2) X FC 701/5 Syn	6830	31.6	13.9	89.1
883	Polish 370/71 CMS X (FC 702/5 X FC 701/5, Syn)	6743	29.1	14.4	90.1
873	E929 CMS X FC 801 Syn	6715	28.6	14.4	90.5
887	(562 CMS X 546) X FC 801 Syn	6715	30.5	13.7	90.3
888	(562 CMS X 546) X F1002	6715	32.3	13.4	89.2
881	(652016s1 CMS X 662119s1) X FC 702/5	6686	28.5	14.4	90.4
900	(562 CMS X 546) X FC 703	6629	29.7	13.8	90.5
847	(100363 CMS X 12166) X Misc. Rh. lines, Syn	6571	30.8	13.6	89.6
822	Mono Hy D2 (check)	7867	32.9	14.6	91.2
	LSD .05	1014	4.40	0.81	1.25

Preliminary Report on Genotype-Herbicide Interaction Study.--G. A. Smith and E. E. Schweizer.

With the increasing use of herbicides to reduce and even eliminate hand labor, and the introduction of newer sugarbeet varieties, the question of genotype vulnerability to herbicides, as they may affect yield, yield components, and quality factors, becomes more important.

In 1977, we initiated a study to determine if genotype X herbicide interactions are a factor with use of several common pre- and post-plant herbicide treatments in sugarbeet. We tested five commercial varieties, five inbred lines, and five F_1 hybrids under three different herbicide regimes. In one of the sequential treatments, Ro-Neet was applied preplant at 3 lb/A followed by a mixture of Betanal (½ lb/A) and Betanex (½ lb/A) applied postplant. In the second sequential treatment, Nortron was applied at 2 lb/A followed by a mixture of Betanal (½ lb/A) and Betanex (½ lb/A) applied postplant. The check consisted of all 15 entries grown without herbicide treatment.

Data collected included root weight, sucrose, purity, and chemical components known to affect purity. In addition, growth suppression ratings

were made at the 8-10 leaf stage. The study was designed as a multi-year study and the data reported here is a preliminary look at the first-year data for yield, yield components, and growth suppression, but not for chemical components affecting purity. A description of the entries included in the test is presented in Table 1. The dry spring conditions at planting and thereafter in 1977 prevented maximum herbicide effect on both beets and weeds. Consequently, dramatic differences between yield components were not observed. Visual evaluation of foliar growth indicated that growth suppression occurred in the following pattern: inbreds > F_1 hybrids > commercial cultivars. However, no significant treatment effects were noted within the inbred, F_1 hybrid, or commercial cultivar groups. Hence, the growth suppression pattern probably resulted from inherent group differences in seedling vigor and not from herbicidal action. This is not to say that under more ideal moisture conditions, herbicidal suppression would not have differentially affected the genotypes. In fact, previous observations with commercial cultivars has repeatedly shown suppression of seedling growth. The possible effect of herbicide on non-sucrose chemical characters as well as another year's data on yield components under more optimal moisture conditions will be reported next year.

Table 1. Entries tested under 3 herbicide regimes.

Entry no.	Seed no.	Description
		Inbreds
901	761073H01	1861 CMS; mm, ♀ in ♀ of US H20
902	761073H0	1861; T.O., mm
903	751069H0	52-305; T.O., MM, rr, ± S12
904	751105H0	FC 506; T.O., mm, rr, LSR
905	751105H01	FC 506 CMS, mm, rr, LSR
		F_1 Hybrids
906	65-9701	F_1, 52-305 CMS X OVANA
907	71-9209	F_1, 52-307 CMS X 51-338, Rr
908	69-9449	F_1, GWI-81 CMS X 318
909	69-9450	F_1, NBI CMS X 318
910	70-9156	F_1, 52-305 CMS X 556
		Commercial Hybrids
911	A77-10	GW Mono Hy D2
912	A77-18	American Crystal ACH 12
913	A77-19	Holly HH26, Lot 406
914	A77-20	74 MSH 149, Great Western
915	A77-21	Beta 1237

Second-Year Survival of Benomyl-Tolerant Strains of Cercospora beticola in the Field in the Absence of Benomyl.--E. G. Ruppel (in cooperation with A. D. Jenkins and L. M. Burtch, Spreckels Sugar Division, Amstar Corporation).

For the second year of a 3-year study, 100 random single-spore isolates of *Cercospora beticola* from each of three sugarbeet fields near Willcox, Arizona, (benomyl-treated, triphenyltin-treated, and nontreated), proved to be highly tolerant to benomyl in laboratory bioassays. All but one isolate grew on a medium with 10 ppm a.i. benomyl, whereas sensitive control isolates were completely inhibited by 1.0 ppm. In 1976, 90% of the isolates from the benomyl-treated and 40% of the isolates from the triphenyltin-treated fields grew on medium containing 1,000 ppm a.i. benomyl. In the 1977 bioassays, only one isolate from the benomyl- and one from the nontreated fields grew on the medium at this concentration.

Electron Microscopy of the Boundary Zone of Lesions Produced by Cercospora beticola in Sugarbeet Leaves.--M. P. Steinkamp and S. S. Martin.

Three to 5 weeks after the inoculation of sugarbeet leaves with *Cercospora beticola*, the lesions produced have enlarged to their maximum size, and there is little or no further enlargement of the necrotic area of the lesion. Lesions are surrounded by an area of healthy tissue ranging from green to wine-red in color. Fungal hyphae are generally thought to be excluded from this area. The boundary zone was originally described by Cunningham (Phytopathology 18:717-751, 1928) as a "cicatrice" or band of wound healing tissue formed by renewed meristematic activity of the leaf mesophyll surrounding a lesion. He ascribed the occlusion of the intercellular spaces in the "cicatrice" to this cell proliferation.

Ultrastructurally the boundary zone appears complex. Fungal hyphae have been observed in this area only along the border with the central necrotic area of the lesion. Cells in the boundary zone appear only partially, if at all, collapsed. Cells near the border with the central area of the lesion may be necrotic, containing amorphous cytoplasmic remnants with negative image membranes that are located in the cell periphery around a central vacuole. Many of these cells also have lamellate formations deposited between the cytoplasmic remains and the interior surface of the cell wall. Moderate amounts of granular, electron-dense material are found in the intercellular spaces as blebs attached to the cell walls or in the angles where two cells abut. Nearer the healthy portion of the leaf, boundary zone cells appear relatively healthy but metabolically more active having more dictyosomes and rough ER than other mesophyll cells. Chloroplasts in these cells may contain many plastoglobuli and some starch, features of chloroplasts in cells affected more directly by the fungus. A prominent feature of the more healthy region of the boundary zone is the presence of large amounts of the intercellular material, which may fill and obliterate the intercellular spaces. In the healthy portion of the leaf outside the boundary zone the amount of this material progressively and rapidly diminishes until it is no longer found.

Even though many cells of the boundary zone appear metabolically active, no evidence of recent or current mitotic activity has been seen. Occlusion of the intercellular spaces appears to be due not to cell proliferation as described by Cunningham, but to the accumulation of the intercellular material.

We are now investigating the chemical nature of this material. The function of the intercellular material also is unknown, but it could be involved in a wound healing response of the plant. It does not appear to be highly toxic to the fungus since fungal hyphae in contact with the material in the lesion proper appear healthy and unaffected. The intercellular material is found in boundary zones regardless of their color, and is clearly unrelated to the wine-red betacyanins that accumulate in these zones.

Electron Microscopy of Lesions Produced by the "Yellow Toxin" of Cercospora beticola.--M. P. Steinkamp and S. S. Martin.

The fungus *Cercospora beticola* produces at least two toxins capable of inducing necrotic lesions when applied exogenously to leaves of sugarbeet. The first is the chemically well-characterized red toxin cercosporin; the effects of this toxin on sugarbeet leaf ultrastructure have been described (1976 Sugarbeet Research Report, p. C40). A less well-characterized yellow toxic fraction (YT) consisting primarily of a mixture of triglycerides also produces necrotic lesions. The degenerative sequence leading to lesion formation after YT application was studied with the electron microscope. Examination showed some similarities to the fungus-induced lesion (described in 1975 Sugarbeet Research Report, p. C28) but several differences compared to cercosporin-induced lesions. One of the earliest effects of the yellow toxin appears to be collapse of the whole cell with little early effect on cell organelles or membrane organization. Occasionally cell wall appositions and granular electron-dense intercellular material were found. Eventually deformation of the chloroplast interior and an increase in the size and number of the plastoglobuli occurred, and granulate electron-dense bodies of unknown origin were found in the vacuolar area. All of the cell contents ultimately degenerate into the amorphous electron-dense cytoplasm that characterizes necrotic cells.

All of the changes associated with the yellow toxin are also found in the fungal-induced degenerative sequence, and some, such as the formation of cell wall appositions, intercellular material and cell collapse, are found in the cercosporin-induced sequence. The major differences between YT-induced effects and cercosporin-induced effects appear to be the early and severe collapse of YT-treated cells before apparent serious effects on cell membrane systems, the increased number and size of plastoglobuli, and the production of the unusual granulate bodies. Although we have not yet studied lesions resulting from exogenous application of the combined toxins, it appears that most if not all of the degenerative changes that occur in the fungal-induced disease can be accounted for by the combined effects of the two toxic materials produced by the fungus.

RHIZOCTONIA ROOT ROT RESEARCH AND BREEDING FOR RESISTANCE (BSDF Project 20B)

Rhizoctonia Resistance, Field Research, 1977.--R. J. Hecker and E. G. Ruppel.

Our 1977 field research on rhizoctonia resistance in sugarbeet was conducted on our BSDF-leased farm where we also conduct the cercospora leaf spot field research. This was the fifth crop year of the 5-year lease on the farm. A new lease has been negotiated to run for 3 years.

The experiments in the rhizoctonia root rot test area were broadcast inoculated July 15 with a tractor mounted four-row granular-materials applicator, except for the selection blocks which were rosette-inoculated. The dry, ground, barley-grain inoculum of *Rhizoctonia solani* (R-9) was broadcast in a band (about 2 inches) over each row at a rate of 8 grams per 20 ft of row in a split application (opposite direction of travel for each application). One-row plots, 20 ft long and 22 inches apart, were planted May 11. Thinning was done between June 6 and June 17. Between September 12 and 15, the roots were lifted and individually rated for severity of rot. The disease index (DI) ratings were based on a scale of 0 to 7 (0 = no evidence of infection, 7 = plant dead and extensively decomposed). The calculated percentage of healthy roots was that proportion of roots with DI ratings of 0 and 1.

Our root rot epidemic in 1977 was excellent, less severe than in 1976. The more moderate infection allowed for better separation of susceptible and moderately resistant lines. The range of disease indices among breeding lines and other materials tested in one large experiment was 1.7 to 6.9, whereas the range in the severely infected 1976 test was 3.4 to 7.0. The intensity of infection achieved in our 1977 experiments was almost ideal.

Evaluation of Contributed Lines.--E. G. Ruppel and R. J. Hecker.

Separate randomized complete block experiments with five replications were used to evaluate a total of 70 contributed lines from American Crystal, Great Western, and Holly Sugar companies for resistance to *Rhizoctonia solani*. In each test, *Rhizoctonia* resistant cultivar FC 703 and susceptible GW 674-56C were included as controls. Results of each company's test were statistically analyzed and sent to company breeders, thus, they will not be reproduced here. As expected, the resistant control and hybrids with resistant parentage were more resistant than entries having no history of selection or breeding for *Rhizoctonia* resistance. The mean disease index across tests for cultivar FC 703 on a scale of 0 to 7 was 2.1, whereas for the susceptible check the mean was 5.4. The range (means) for all company lines was 2.3 to 6.3. Mean percentage healthy roots (0 + 1 classes) was 45.2% for FC 703 and 4.5% for GW 674-56C. The range (means) for all company lines was 0 to 37%.

Breeding for Increased Resistance to Rhizoctonia Root Rot.--R. J. Hecker and E. G. Ruppel.

Losses of the sugarbeet crop due to rhizoctonia root rot continue to be chronic. Observations and communications with sugarbeet production people throughout the country indicate that losses are increasing in certain production areas. Hence, it appears likely that the results of our resistance breeding efforts and related research will be of increasing value in the future.

We have two general objectives in our rhizoctonia research, namely, the development of adequate levels of resistance to this soil-borne fungus, and research on breeding and cultural methods whereby these adequate levels of resistance can be incorporated into productive varieties. Our breeding program involves three approaches: recurrent selection for rhizoctonia resistance, mass selection, and pedigree breeding. We would anticipate that recurrent selection should have the greatest potential. Via this breeding method, we would hope to increase resistance to the disease while maintaining geneticheterogeneity for production characteristics so that synthetics resulting from the recurrent selection program might be used either as parents in hybrids or as sources from which potential hybrid components could be derived. Since resources are limited, only the most promising breeding lines are included in our recurrent selection program. New and less promising lines are carried in the mass selection program which requires considerably less resources. The pedigree breeding program is designed to achieve genotypes which are genetically homozygous for the highest levels of resistance. This method leads to rather intense inbreeding and the loss of genetic heterozygosity, but it appears to be our most effective means of concentrating and purifying genes for resistance.

Our most resistant lines, and various other materials of interest, are evaluated each year for their relative rhizoctonia resistance. Table 1 lists those lines in the 1977 test which were of greatest interest. There were a total of 90 entries in the experiment. Entry 480 is the most resistant entry in the experiment with a disease index (DI) of 1.8. This is a synthetic developed by mass and recurrent selection from the F_2 of FC 701 X LSR-CTR mm TO lines; it is segregating for monogerm. Entry 459 with a DI of 2.6 is also very promising. It is a monogerm synthetic from the same F_2. Among the multigerm entries, 458 with a DI of 2.1 is the most resistant. It resulted from three cycles of mass selection from FC 703 using a greenhouse selection technique which was developed. Entry 455 is the German red beet tester with some selection for intensification of red color. This entry never has been selected for resistance to *Rhizoctonia*; however, it has a DI of 3.5. This is the highest level of inherent resistance to *Rhizoctonia* that we ever have detected among the nearly 2,000 lines and strains that we have tested since the inception of our rhizoctonia research project. We have proceeded to cross this source of resistance with resistant lines that have come from our breeding program, with the objective of obtaining transgressive segregates for resistance and to determine if the resistance in this red beet is different from our lines which were bred for resistance. Numerous other entries are included in this experiment, i.e., untested lines, breeding lines, and commercial varieties.

Table 1. Rhizoctonia resistance of breeding and miscellaneous lines assessed by disease index (DI) and % healthy roots. Means followed by the same letter are not significantly different (P = .95).

Entry no.	Populations and description	DI Mean	DI % of check	% healthy
Multigerm Lines				
455	Red beet tester	3.5 efgh	125	25
457	Syn_1 from FC 702/5 X FC 701/5, F_2	2.4 ijk	86	36
458	3 cy. greenhouse sel. from FC 703	2.1 jk	75	45
460	3 cyl sel. for Rhizoc. damping off resist.	2.8 ghij	100	35
461	1 cy. sel. from AJ_1ZZ (Polish)	6.0 abcd	214	7
464	1 cy. sel. from EL-42	3.5 efgh	125	29
465	1 cy. sel. from phoma resist. FC 701/4	2.9 ghij	104	30
476	Syn_4 from FC 701	2.2 jk	79	39
487	Syn_1 from misc. sources	2.9 ghij	104	29
488	Syn_1 OP_1 from 5 diverse resist. sources	3.0 ghij	107	26
490	Syn_1 from FC 801	3.6 efg	129	26
495	FC 701/4	3.0 ghij	107	32
502	FC 701/4 (4X)	3.0 ghij	107	31
498	2 cy. sel. from USSR lines	5.2 d	186	10
499	EL-42	4.1 ef	146	20
505	FC 702/5; 9 cy. sel.	3.3 fghi	118	30
513	FC 702/5; Mother line Syn	2.6 hij	93	40
514	FC 701/5; Mother line Syn	2.6 hij	93	34
515	FC 703; Mother line Syn	2.7 ghij	96	28
516	FC 801; Mother line Syn	4.0 ef	143	21
523	Pooled progeny lines of GW 674 & C 817	2.4 ijk	86	38
527	Beta maritima (biennial; Polish)	6.5 ab	232	2
536	F 1001; Fargo rot resist. line from USSR line	5.5 cd	196	10
537	F 1002; Fargo rot resist. line from FC 701/4	4.2 ef	150	16
542	EL-43	4.3 e	154	21
511	FC 703 (4X)	3.2 fgh	114	26
544	FC 703; resistant check	2.8 ghij	100	26
Monogerm lines or segregating for monogerm				
459	Mono Syn_1 from FC 701 X LSR-CTR mm TO lines	2.6 hij	93	30
467	Polish 370/71 CMS	6.6 ab	236	2
469	♀ parent of US H20	6.9 a	246	0
471	FC 504 CMS X FC 502/2	6.0 abcd	214	6
473	FC 506 CMS	6.3 abc	225	2
475	FC 603 CMS	6.8 a	244	0
480	Syn_1 from FC 701 X LSR-CTR mm TO lines	1.8 k	64	49
485	Syn_1 from FC 702 X mm TO lines	2.8 ghi	100	32
486	Syn_1 from SP 5831-0	2.7 ghi	96	32
529	Mono Hy D2	5.9 bcd	211	2
530	ACH-14	6.1 abcd	218	0
531	HH 26	6.4 abc	229	3
532	US H20	6.3 abc	225	3
533	US H10B	6.6 ab	236	0
534	74 MSH 149	6.4 abc	229	0
535	Beta 1237	6.1 abcd	218	8

Each year we test some of the more promising multigerm breeding lines as potential pollinators. The yield of a number of these experimental hybrids is reported in another section of this report.

The most resistant materials in our rhizoctonia nursery in 1977 were some partially inbred lines coming out of our pedigree breeding program. The best of these had a DI of 1.3 with 75% of the roots showing no active infection. These entries were included in our selection blocks where we made within-line and between-line selections.

From a comparison over years, it is apparent that we are continuing to make a small increment of improvement for resistance each cycle. Also, we are reaching the point where yield losses due to rhizoctonia root rot in some of our most resistant lines are very small even though, perhaps, only 50% of the roots are healthy or infection free. The vast majority of the remaining roots have only small active infection sites, and none of the plants are killed by the rot. From the apparent multigenic, horizontal, and partially dominant resistance, one of our objectives is to develop genotypes which are virtually infection free so that a high level of resistance might be transferred into the parents of hybrids. Our previous experiments have shown that relatively high resistance in the pollinator parent, especially if the pollinator is tetraploid, may provide sufficient resistance in the resulting hybrid for most commercial *Rhizoctonia* problem areas. Low heritability remains a problem in the rapid incorporation of resistance into other lines by backcrossing.

We are continuing to search for a more precise means of genotypic assessment of individual plants with respect to resistance. We have not yet found a promising biochemical, greenhouse, or mechanical technique.

Maternal (Reciprocal) Effects on Rhizoctonia Root Rot Resistance in Sugarbeet.--R. J. Hecker and E. G. Ruppel.

Previously, we reported that we had no evidence of reciprocal differences for rhizoctonia root rot resistance. However, those data were rather limited. We now have additional reciprocal hybrids which we tested during 1977.

In 1977 we used three susceptible and two resistant cultivars which were segregating for hypocotyl color; thus, we were able to use red or green hypocotyl plants from each population depending on whether we wanted to use them as male or female. All these cultivars have normal cytoplasm. The resulting six hybrids and their reciprocals are listed in Table 1. The last hybrid in the table had significantly different reciprocals, the disease index being 4.8 when the resistant parent was used as a female, and 6.0 when the resistant parent was used as a pollinator. However, the mean of all the hybrids was not significantly different from the mean of the reciprocals. Hence, as in our previous report, there does not appear to be any good evidence for reciprocal differences for rhizoctonia root rot resistance among hybrids from parents with normal cytoplasm.

In 1977, we also had an experiment involving the comparison of equivalent hybrids with sterile and normal cytoplasm. The results, which were

found to be in favor of the hybrids with sterile cytoplasm, may be confounded with a stand problem in the normal cytoplasm hybrids. A new set of hybrids will have to be generated and tested in 1979. We reported previously on very limited data that there was no difference between hybrids carrying sterile or normal cytoplasms.

Table 1. Disease index (DI) of reciprocal hybrids with normal cytoplasm.

Hybrid	Resist. parent used as ♂		DI		Resist. parent used as ♀
67-436 (susc.) X FC 703 (resist.)	5.0	←	NS	→	4.4
67-436 (susc.) X FC 702/5 (resist.)	6.1	←	NS	→	6.3
USSR mono (susc.) X FC 703	4.0	←	NS	→	4.3
USSR mono (susc.) X FC 702/5	5.4	←	NS	→	4.7
GW 674 (susc.) X FC 703	4.3	←	NS	→	4.6
GW 674 (susc.) X FC 702/5	6.0	←	*	→	4.8
Mean	5.1	←	NS	→	4.9
GW 674; susc. check			6.5		
FC 703; resist. check			2.7		

Susceptibility of Rotation Crops to a Root Rot Isolate of Rhizoctonia from Sugarbeet.--E. G. Ruppel.

Barley, bean, corn, and sorghum plants inoculated at planting in the greenhouse and at 2, 4, and 8 weeks of age with isolate R-9 of *Rhizoctonia solani* (200 μg dry barley grain inoculum/g soil) developed typical lesions within 30 days. Percentage isolates of *Rhizoctonia* from lesions were 17, 50, 54, and 54 from these crops, respectively. All *Rhizoctonia* isolates except one were of the same anastomosis group as R-9, and these were pathogenic to sugarbeet. Infected debris of these crops may serve as sources of primary inoculum for subsequent sugarbeet crops; however, the longevity of the fungus within debris of the different crop species must be determined.

Effect of Nitrogen Fertility Level on Intensity of Rhizoctonia Infection in the Field.--R. J. Hecker and E. G. Ruppel.

Reports in the literature show conflicting results on the effect of nitrogen fertilization on intensity of rhizoctonia root rot infection under field conditions. In this report in 1976, we related that high levels of nitrogen fertility, when added by side-dressing on a standard preplant nitrogen application, had no significant effect on the overall severity of root rot in a susceptible sugarbeet variety planted in a field infested with *Rhizoctonia solani*. In 1977, we had a field experiment which included susceptible, intermediate, and resistant cultivars grown under two nitrogen regimes, 80 and 200 pounds of applied nitrogen (as ammonium nitrate), plowed down. From a soil test for residual nitrogen, it was determined that 80 pounds would have been the commercially recommended amount, whereas 200 pounds was, of course, excessive.

The results are shown in Table 1. There were significant differences among the entries, but no significant entry X fertility interaction. The disease indices within the two fertility levels were not significantly different. Hence, we must conclude, from a previous experiment and this 1977 experiment in which abundant nitrogen was available all season, that the degree of root rot severity was not significantly affected by nitrogen fertility. Therefore, nitrogen fertilization could not be considered a remedial measure for infection by *R. solani*.

Table 1. Disease index (DI) for rhizoctonia root rot of three cultivars at two N fertility levels.

Cultivars	Applied N	
	80 lbs/A	200 lbs/A
FC 703; resistant	3.1	3.4
FC 801; medium resistant	4.1	4.6
C 817; susceptible	6.3	6.3
Mean	4.5	4.8

<u>Dominance for Rhizoctonia Resistance</u>.--R. J. Hecker and E. G. Ruppel.

In previous reports, we have noted the presence of partial dominance for resistance to rhizoctonia root rot. The data in Table 1 from a 1977 experiment in the inoculated nursery, indicated the general presence of partial dominance for resistance. However, there were in the group of 18 hybrids in Table 1 two exceptions to this general pattern, i.e., P_5 X P_8 and P_3 X P_{10}. The DI's for these two hybrids are not significantly different than their midparent values. These results provide further evidence that there are a few exceptions to the usual case of partial dominance for resistance.

A difference in degree of dominance due to the resistant parent is apparent from examination of groups of half-sib hybrids with different pollinators. Among the pollinators (P_6 through P_{10}) in this experiment, P_6 demonstrated a greater degree of dominance than any of the others, in spite of the fact that it is not among the most resistant pollinators, having a DI of only 2.9. P_8 on the other hand was the most resistant of the pollinators, yet its resultant hybrids were not as resistant as those produced by the pollinator P_6. Very little dominance was demonstrated by P_9 (Syn FC 801).

These data indicate that one might generally expect partial dominance for resistance, but there may be some exceptions. Also, all resistant lines do not impart the same degree of dominance. These two things further indicate that the pollinator parents in this experiment obviously carry some genetic differences for resistance. Routinely, in our breeding program, we recombine our better sources of resistance and use these populations as new selection sources with the hope of isolating transgressive segregants for resistance.

Table 1. Rhizoctonia root rot disease index (DI) of some parents and their hybrids.

Entry no.	Parent or hybrid	Rhizoc. class	DI	Mid-parent DI
	♀'s			
467	P_1; Polish 370/71 CMS	Susc.	6.6	
469	P_2; ♀ of US H20	Susc.	6.9	
471	P_3; FC 504 CMS X FC 502/2	Susc.	6.0	
473	P_4; FC 506 CMS	Susc.	6.3	
475	P_5; FC 603 CMS	Susc.	6.8	
	♂'s			
465	P_6; Phoma resist. sel. from FC 701/4	Resist.	2.9	
476	P_7; Syn FC 701/5	Resist.	2.2	
480	P_8; Syn (FC 701 X mm, TO lines)	Resist.	1.8	
490	P_9; Syn FC 801	Resist.	3.6	
495	P_{10}; FC 701/4	Resist.	3.0	
	Hybrids			
466	P_1 X P_6		3.5	4.8
468	P_2 X P_6		3.5	4.9
470	P_3 X P_6		3.2	4.4
472	P_4 X P_6		3.9	4.6
474	P_5 X P_6		4.0	4.8
479	P_3 X P_7		3.4	4.1
478	P_4 X P_7		3.5	4.2
477	P_5 X P_7		4.0	4.5
483	P_1 X P_8		3.5	4.2
484	P_2 X P_8		3.8	4.4
482	P_4 X P_8		3.9	4.1
481	P_5 X P_8		4.6	4.3
493	P_2 X P_9		4.8	5.3
494	P_3 X P_9		4.4	4.8
492	P_4 X P_9		4.7	5.0
491	P_5 X P_9		5.0	5.2
496	P_2 X P_{10}		4.8	5.0
497	P_3 X P_{10}		4.7	4.5

EPIDEMIOLOGICAL AND BIOLOGICAL INVESTIGATIONS ON POWDERY MILDEW (BSDF Project 50)

Sugarbeet Powdery Mildew in 1976-77.--E. G. Ruppel.

Reports received during the 1977 crop year and personal observations indicated that powdery mildew generally followed the same pattern of development and spread as noted in the past 3 years. The disease occurred to some extent in all areas where sugarbeets were grown, and appeared at least 1 month earlier in some regions. Control with sulfur formulations appeared adequate. No perfect (sexual) stage was confirmed from any area.

Effect of Aldicarb on Powdery Mildew Symptoms in Seedling Sugarbeets.--E. G. Ruppel and B. J. Tomasovic.

Aldicarb was stated to increase susceptibility of sugarbeet seedlings to powdery mildew (Abivardi & Altman, *personal communication*). To evaluate aldicarb for use in a resistance screening program incorporating normally-resistant seedlings, concentrations of 0, 2, 4, 8, and 16 ppm were compared. Aldicarb was mixed with soil and seeds were planted. Pots were maintained in a growth chamber under conditions conducive to powdery mildew development (see next report), and seedlings were inoculated at first true leaf stage. No visual differences in disease severity were evident among treatments at 7, 14, and 21 days after inoculation.

Growth Chamber Environment for Powdery Mildew Development in Sugarbeet.--E. G. Ruppel.

Although powdery mildew developed under a wide range of conditions in plant growth chambers, the most favorable conditions were found to include a 16-hour day at 21-23 C, and an 8-hour night at 14-16 C. Fluorescent-incandescent light at 11,840 lux was supplied during the day period, whereas a constant relative humidity of 50% (±5%) was maintained. These conditions, which resulted in severe infections of older plants, did not overcome the inherent resistance of seedlings.

SUGARBEET RESEARCH

1977 Report

Section D

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Abstracts of Papers Published or Approved for Publication

1. Bugbee, W. M. Storage Rot of Sugarbeet. ARS-NC-56, 17 p., Oct. 1977. Review article.

2. Bugbee, W. M. Registration of Germplasm with Resistance to Three Storage Rot Pathogens. Crop Science, approved June 1977. F1001, a selection from U.S.S.R. introduction VNIS F526 and F1002 a selection from FC701/4 were released as sources of resistance to *Phoma betae*, *Botrytis cinerea*, and *Penicillium claviforme*.

3. Cole, D. F. and G. J. Seiler. Effect of Crown Material on Yield and Quality of Sugar Beet Roots: A Grower Survey: JASSBT 19:130-137. A survey of commercial sugar beet growers in the Red River Valley of North Dakota and Minnesota was conducted to determine the change in tonnage and root quality that would occur if sugar beets were flailed rather than topped conventionally at harvest. The data indicated that the growers removed only 20% of the crown material by topping, which reduced tonnage by 5%.

   Removal of all the crown material by hand resulted in a 1.2% increase in sucrose and a 7.1% reduction in nitrate grade. Sugar beet crown material accounted for 20.5% of the tonnage delivered to the factory.

Sugarbeet Storage Rot Research

W. M. Bugbee and D. F. Cole

USDA, Science and Education Administration,

in cooperation with the

North Dakota Agricultural Experiment Station, Fargo

TBZ and Genetic Resistance

The use of thiabendazole (TBZ, Mertect) to reduce storage rot is increasing. Genetic resistance is another way of controlling storage rots. The test reported here was designed to compare TBZ and resistant genotypes for control of storage rots caused by _Phoma betae_, _Botrytis cinerea_, and _Penicillium claviforme_.

Roots were inoculated by rotating a cork borer with serrated edges 10-15 mm into the root. The cork borer was dipped into conidia suspended in 0.1% water agar. The borer was sterilized by alcohol-flame for a wounded but uninoculated treatment. The roots then were dipped in a Mertect flowable formulation at 1500 ug/ml of TBZ, drained, bagged in perforated plastic bags and stored at 5°.

Rot was measured by cutting out and weighing the darkened tissue. The amount of rot was expressed as percent by weight.

Results.--The amount of rot that developed in the resistant genotypes 7327 and 75P1 was significantly less than that which developed in the two commercial cultivars American 2 hybrid B (2B) and Mono Hy D2 (D2) (Table 1). But when the commercial cultivars were dipped in TBZ, the amount of rot that developed was similar to that of the resistant genotypes. The amount of rot in the wounded uninoculated roots was similar to the inoculated roots. This supports the observations that naturally occurring inoculum is present on roots and that rot will occur if the roots are wounded. Rot also developed in the unwounded roots. This was a measure of naturally occurring rot. Most of it was caused by _P. betae_.

This experiment is being repeated to gather second year's data, but a tentative conclusion is that these resistant genotypes and TBZ afford similar levels of storage rot reduction.

Seed-borne Phoma

Seed can become infected with *P. betae* in the seed fields. Once the seed is infected, eradication of the pathogen with approved fungicidal seed treatments is difficult. In this experiment, fungicides were applied to the developing seed crop to test the possibility of protecting seed from infection prior to harvest.

Mother roots from the 1976 crop were planted in the field in May 1977 to serve as the source of the seed crop. Each plot contained two rows each with six roots spaced 2 feet apart in each direction (12 roots). Fungicides were applied in 20 gal of water/A on August 22. At this time seed were maturing. Each plot was inoculated the following day with 50 ml of a suspension of 5.75 million conidia/ml of *P. betae*. The temperature was 50°F with light drizzle and the weather during the following two weeks was very conducive to seed infection. The seed were harvested six weeks later and dried at 95°F.

The assay for seed-borne *Phoma* and sand emergence were performed on raw seed. Results for the polished seed are not yet available. Ten seed were placed in each of five petri dishes of a medium selective for *Phoma*. The prevalence of *Phoma* was measured after 10 days incubation at 20-22°C. Seed were planted 1 1/2 inches deep in sterile sand in the greenhouse and emergence counts taken after two weeks.

Results.--Stand counts and the percentage of infected seed were extremely variable. Significant differences among means could only be detected at the 10% level. The data in Table 2 shows that the lowest incidence of seed infection occurred when seed plants were sprayed with EL-228. This experimental fungicide also proved to be effective against *Phoma* in laboratory tests. Although EL-228 caused a 50% reduction of infected seed compared to the inoculated-no fungicide control treatment, the stand counts between these two treatments were nearly the same. This supports other data that says stand counts do not necessarily indicate the prevalence of *Phoma* in the seed lot. This test will be repeated and redesigned to reduce variability.

Early evaluation of storage rot resistance

Last year's data suggested that resistance: 1) to *Botrytis* could be detected in immature (80 days after planting) roots after the roots had been stored 30 days at 5°; 2) to *Phoma* could be detected in mature (160 days after planting) roots under the same storage conditions and; 3) to *Penicillium* in mature roots without storage. A second year's test currently is in progress to confirm these conclusions.

The concept of testing immature roots is being investigated further by evaluating stecklings and seedlings produced in the greenhouse. Small cores were taken from greenhouse stecklings and handled as with our standard method. The stecklings were produced from a susceptible commercial cultivar and a

resistant breeding line. Rot reactions had been determined earlier using the standard method. The data in Table 3 shows that stecklings reacted to the three storage pathogens in a predictable way. Stecklings from the susceptible host were still more susceptible than those from the resistant host. The differences were not great with *Phoma* or *Penicillium* but a considerable difference existed with *Botrytis* when the stecklings were stored at 5° for 30 days.

A second test (Table 4) confirmed results of the first test and those from the field: a differential reaction to *Botrytis* was most evident after immature roots were stored at 5° for 30 days.

The second test also showed that a differential response of freshly harvested stecklings to *Phoma* could be detected but the difference was too small, in my opinion, to be reliable. Greater differences between the susceptible and resistant roots were apparent after the stecklings had been stored at 20° for 30 days.

The variable reactions to *Penicillium* accounted for the nonsignificant differences. The resistant breeding line had not been selected for resistance to this pathogen. Therefore, at this point, it is not clear whether immature roots can be selected for resistance to *Penicillium*.

Nitrogen fertility and storage rot

Previous unpublished results have indicated that sugarbeets are more susceptible to storage rot when grown under inadequate nitrogen levels. Data reported here from a second experiment confirm this conclusion. The roots were obtained from a nitrogen fertility test conducted by A. D. Halvorson at the Montana Agricultural Experiment Station, Sidney. Roots were stored for 150 days at 5° then cores were removed and placed on pure cultures of *Phoma*, *Botrytis*, or *Penicillium*. Cores were incubated for 2 weeks at 20-22° then cut longitudinally and assigned a rot index.

Results.--Roots that were grown in soil that had received 0, 55, or 110 (0, 50 or 100 lbs/A) Kg N/ha were more susceptible to *Phoma* and *Botrytis* than roots grown in soil that had received 440 Kg N/ha (400 lbs/A). Rot caused by *Penicillium* was not affected by N fertility (Table 5).

These results suggest that roots considered by the processor as being of low quality (high impurity level) probably will not be affected by *Phoma* and *Botrytis* as much as roots of high quality.

Release of storage rot resistant germplasm

Two breeding lines were released and registration of the germplasms was approved.

F1001 is a selection from the multigerm U.S.S.R. introduction VNIS F526. It has a high level of resistance to *P. betae* and moderate resistance to

P. claviforme. F1002 is a selection from multigerm FC 701/4, a line developed at Ft. Collins for resistance to *Rhizoctonia*. It has a high level of resistance to *P. betae* and moderate levels of resistance to *B. cinerea* and *P. claviforme*.

Table 1. The Effect of Thiabendazole (TBZ) or Genetic Resistance on Phoma Storage Rot

Host	Amount of Rot by Weight WO/TBZ	Amount of Rot by Weight W/TBZ
	%	%
2B susceptible	11.7 a	7.3 c
D2 susceptible	13.2 a	3.2 b
7327 resistant	8.5 c	--
75P1 resistant	3.3 b	--

Means followed by the same letter do not differ based on:
$lsd_{.05} = 1.96 \sqrt{12.998 \left(\frac{ni+nj}{ni.nj}\right)}$

Table 2. The Effect of Pre-Harvest, Seed-Field Applied Fungicides on Seed Infection by *Phoma betae* and Emergence

Treatment	a.i./A	Raw Seed Infected	Raw Seed Emergence
		%	No.
Inoculated No fungicide		32	36
Thiabendazole	6.7 oz	30	35
Untreated check		28	27
M-144	8 oz	27	15
Ethylenebis...	16 oz	25	25
Benomyl	8 oz	24	37
EL-228	120 gm	17	38
$lsd_{.10}$		13	13

Fungicides were applied by spraying at 20 gal/A.

Table 3. Reaction of Stored Greenhouse Stecklings to Three Pathogens. The Host Reaction was Determined from Previous Standard Tests with Older Roots.

Host Reaction	Storage time	Storage temp	Pathogen Phoma	Pathogen Botrytis	Pathogen Penicillium
	days	°C	rot index [a]		
Commercial susceptible	30	5	1.0	5.0	2.8
		20	2.2	5.0	3.8
	80	5	3.0	6.0	3.5
		20	6.0	6.0	6.0
Resistant breeding line	30	5	0.8	1.5	2.0
		20	2.2	3.8	2.8
	80	5	2.2	4.0	2.9
		20	5.0	6.0	5.2

a/ see Table 4

Table 4. Reaction of Greenhouse Stecklings to Three Pathogens. The Host Reaction was Determined from Previous Standard Tests with Older Roots. (Test 2)

	Storage		Storage Pathogen		
			Phoma	Botrytis	Penicillium
	days	°C		rot index a/	
Commercial susceptible	0		1.6	1.5	3.1
	30	5	1.8	3.2	3.1
	30	20	3.6	3.7	3.4
	80	5	1.8	2.6	3.1
	80	20	5.9	4.6	5.8
Resistant breeding line	0		0.6	1.0	2.4
	30	5	0.2	1.1	2.1
	30	20	1.8	1.7	2.4
	80	5	0.2	1.2	1.6
	80	20	3.4	3.6	2.9
$lsd_{.05}$			.5	.6	ns

a/ rot index is based on the distance rot progressed along a core taken from a root: 0 = 0 mm; 1 = 1-5 mm; 2 = 6-10 mm; 3 = 11-15 mm; 4 = 16-20 mm, etc.

Table 5. Reaction to Three Storage Rot Pathogens of Roots Grown Under Different Nitrogen Levels and Stored at 5° for 150 Days.

N rate/ha	Phoma	Botrytis	Penicillium
Kg	— rot index a/ —		
0	3.4	3.5	3.0
55	2.7	2.5	2.0
110	2.9	2.9	2.4
440	1.8	1.3	2.2
11 T manure	2.7	2.4	2.0
lsd, p=0.01	0.5	0.8	ns

a/ rot index: see Table 4

SUGARBEET PHYSIOLOGY

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Storage experiments were conducted during the 1974-75 and 1976-77 storage periods to determine the effect of nitrogen on respiration and sucrose loss in sugarbeet roots. The roots were from a nitrogen experiment conducted at Sidney, Montana, and stored at 40F and 100% relative humidity at the Sugarbeet Research Center on the NDSU Campus. Respiration was significantly affected by application of 400 lb N/acre during both storage periods (Table 1).

Table 1. Effect of Nitrogen on Respiration

Nitrogen added, lb/a	Storage Period 1974-75	1976-77
	mg CO_2/kg/hr	
0	1.58	1.97
50	1.70	1.89
100	1.52	1.90
400	2.12	2.16
10 Ton manure/a	-	1.95
LSD 0.05 level	0.18	0.16

No differences in respiration was detected among the other nitrogen levels (0, 50, 100 lb N/A). Also, 10 tons of manure/A did not affect respiration.

Quality data reported previously indicates that excessive nitrogen reduces quality of the roots and increases the amount of crown tissue produced by the plants. The data reported in this experiment indicates

that excessive nitrogen reduces sugarbeet quality at harvest and excessive nitrogen can cause a significant increase in sugar loss during the post-harvest period by increasing the respiration rate.

Data reported previously has indicated that respiration causes the major loss of sugar during the post-harvest storage period. Respiration is affected by temperature, variety, mechanical damage, and storage decay. A major objective of the ARS research program is to determine methods to reduce respiration in sugarbeet storage piles. Temperatures in the pile should be lowered as rapidly as possible to near 40F to reduce respiration losses since temperature has the largest effect on respiration rates. Once temperature is controlled then other methods may be effective in further reducing the respiration rate of stored sugarbeets.

Mechanical damage to the roots can be reduced by not scalping the roots. Considerable data has been reported that by removing the leaves and petioles, only respiration would be reduced, with a minimum increase in the impurity load of the factory.

Another method to reduce respiration is to select varieties that exhibit low rates of post-harvest respiration. Other workers have shown that respiration is an inherited characteristic.

In the 1974-75 storage period, a selection program was initiated to select sugarbeet lines with low respiration rates.

Sugarbeet roots have been selected by determing the amount of CO_2 (the end product of respiration) in the root. This is accomplished by removing a 1 x 6 cm core from the main body of the roots, sealing the cavity with a serum stopper, and removing a gas sample with a syringe 24 to 72 hours after the removal of the core. Carbon dioxide (CO_2) is then determined by gas chromatography using a silica gel column. Significant reduction in the internal CO_2 levels were accomplished during the selection period (Table 2).

Table 2. Selection for Low Internal CO_2

	Group	
Population	1	2
	percent	
Original	1.679	1.681
Cycle 1	1.387	1.597
Cycle 2	1.255	1.446
Cycle 3	1.144	1.295
Commercial hybrid	1.512	

The data reported is from evaluations completed in the 1977-78 storage period. The roots tested in cycle three of both groups are significantly lower in internal CO_2 levels than roots from a standard commercial hybrid included in the test. Storage tests are in progress to determine the quality of these selections compared to commercial hybrids.

Some of the major impurities in sugarbeet roots have been identified as sodium, potassium, amino acids, and reducing sugars. However, the specific location of these impurities in the roots have not been identified. It is generally accepted that crown tissue is lower in sucrose and contains more impurities than root tissue. Recent data has indicated that the difference in quality of root and crown tissue is affected by nitrogen fertilizer and by varieties. The objective of this study was to determine the effect of leaf removal, varieties, and potassium fertilizer on the concentration of sucrose and the above mentioned impurities in specific tissues of sugarbeet roots.

Sucrose is concentrated in the outer rings of the root and in the vascular tissues of the root and crown (Table 3). The lowest concentration of sucrose is in the epidermal tissues and the pith tissue of the crown. The impurities are concentrated in the tissues where sucrose is the lowest. Removal of the older leaves reduced the sucrose concentration in all tissues. Reducing sugars and potassium levels were reduced, sodium levels were increased, and amino acids were not affected by removing the older leaves. Removal of the new leaves resulted in lower potassium levels and the other impurities were not affected (Table 3).

In another experiment where varieties and potassium fertilizer were the main variables, significant differences were observed in sodium and potassium levels of different tissues (Table 4). Sodium and potassium was concentrated in the parenchyma and pith tissues. No differences were detected between the vascular tissue of the crown and roots for sodium levels. The vascular tissue of the crown was higher in potassium than the vascular tissue of the root.

Varieties were significantly different in the amount of sodium and potassium in the roots. ACH-14 accumulated less sodium and potassium than Beta 1934 and ACH-17. GW D-2 contained less sodium than Beta 1934 and ACH-17 but no differences were detected in potassium levels of these three varieties. GW D-2 had more potassium than ACH-14 but was no different in sodium levels (Table 4).

Potassium fertilizer increased potassium and reduced sodium levels in the roots. Apparently, under low potassium levels, sodium can partially replace potassium in the plants metabolism.

The data shown in Tables 5, 6, and 7 are the various interactions between tissues, varieties and potassium fertilizer.

Table 3. Effect of tissues and leaf removal on phenol-sulfric sugars, reducing sugars, amino acids, sodium, and potassium levels and sodium: potassium ratios in sugarbeet roots.

Tissue	Sucrose	Reducing sugars ppm	Amino acids ppm	Sodium ppm	Potassium ppm	Sodium / Potassium ratio
Central core	13.9 b*	751 c	3971 cd	867 c	2222 d	0.40 ab
Vascular 1	14.2 b	739 c	4182 d	876 c	2145 d	0.43 a
Vascular 2	14.0 b	833 c	5165 c	854 c	2233 d	0.40 ab
Parenchyma 1	9.9 c	3437 b	12034 b	1529 b	6457 b	0.26 bc
Parenchyma 2	9.4 cd	4003 ab	14079 ab	1465 b	6464 b	0.24 c
Outer rings	16.5 a	357 c	4856 cd	317 d	1898 d	0.19 c
Root epidermis	5.3 e	5525 a	16876 ab	1474 b	10455 a	0.16 c
Crown pith	5.3 e	1689 c	17049 a	1074 b	7209 b	0.18 c
Crown vascular	15.2 ab	456 c	7509 c	246 d	1773 d	0.16 c
Crown epidermis	8.0 d	4091 ab	7690 c	2026 a	5517 c	0.39 ab
Leaves Removed						
None	11.7 a	2725 a	9771 a	916 b	4995 a	0.23 b
New	11.5 a	2174 a	9763 a	1143 a	4341 b	0.32 a
Old	10.3 b	1665 b	8490 a	1160 a	4575 b	0.29 a

* Means followed by the same letter in a column of main effects are not significantly different at the 0.05% level (Duncan's Multiple Range Test).

The data reported indicates that impurity levels are affected by several parameters and the impurities are located in tissues where sucrose is lowest. However, it may be possible to reduce the impurity levels by selecting genotypes with an increased amount of vascular tissue in the root and with less pith tissue in the crown.

Table 4. Effect of tissue, variety and potassium fertilizer on sodium, potassium, and sodium: potassium ratio in sugarbeet roots.

Tissue	Sodium ppm	Potassium ppm	Sodium / Potassium Ratio
Central core	170 c*	1187 de	0.14 b
Vascular 1	148 c	1152 e	0.14 b
Vascular 2	143 c	1147 e	0.14 b
Parenchyma 1	442 b	2258 b	0.28 a
Parenchyma 2	391 b	1835 c	0.29 a
Outer rings	107 c	1057 e	0.11 b
Crown pith	634 a	6264 a	0.16 b
Crown vascular	127 c	1480 d	0.10 b
Variety			
ACH-14	201 c	1836 c	0.14 b
GW Mono-Hy D2	204 c	2087 ab	0.14 b
Beta 1934	406 a	2256 a	0.23 a
ACH-17 Hy 2B	270 b	2011 b	0.18 b
Potassium Fertilizer			
0	356 a	1645 b	0.25 a
200 lb/A	184 b	2450 a	0.09 b

* Means followed by the same letter in a column of main effects are not significantly different at the 0.05% level (Duncan's Multiple Range Test).

Table 5. Effect of tissues and varieties on sodium and potassium levels in sugarbeet roots.

Tissue	ACH-14	GW Mono-Hy D2	Beta 1934	ACH-17 Hy-2B
		Sodium, ppm		
Central core	152	128	218	182
Vascular 1	126	116	222	128
Vascular 2	117	111	199	143
Parenchyma 1	252	319	801	396
Parenchyma 2	216	248	737	361
Outer rings	100	94	127	107
Crown pith	521	517	776	722
Crown vascular	119	100	167	122

LSD (0.05) = 136

n = 32

Tissue	ACH-14	GW Mono-Hy D2	Beta 1934	ACH-17 Hy-2B
		Potassium, ppm		
Central core	1174	1080	1369	1123
Vascular 1	1144	1059	1342	1064
Vascular 2	1060	1069	1328	1129
Parenchyma 1	1746	1962	3238	2086
Parenchyma 2	1245	1545	2644	1900
Outer rings	990	1132	1100	1004
Crown pith	5871	7208	5569	6411
Crown vascular	1455	1636	1455	1375

LSD (0.05) = 584

n = 32

Table 6. Effect of varieties and added potassium fertilizer on sodium levels in sugarbeet roots.

Potassium Fertilizer	ACH-14	GW Mono-Hy D-2	Beta 1934	ACH-17 Hy-2B
		Varieties		
		sodium, ppm		
0	257	267	566	336
200 lb/A	144	142	246	204

LSD (0.05) = 68

n = 128

Potassium Fertilizer	ACH-14	GW Mono-Hy D-2	Beta 1934	ACH-17 Hy-2B
		potassium, ppm		
0	1574	1680	1763	1564
200 lb/A	2098	2494	2748	2459

interaction non-significant

n = 128

Potassium Fertilizer	ACH-14	GW Mono-Hy D-2	Beta 1934	ACH-17 Hy-2B
		ratio		
0	0.20	0.20	0.35	0.26
200 lb/A	0.09	0.08	0.10	0.10

LSD (0.05) = 0.06

n = 128

Table 7. Effect of tissues and added potassium fertilizer on sodium and potassium levels and on sodium: potassium ratio in sugarbeet roots.

Tissue	Potassium fertilizer 0	200 lb/A	0	200 lb/A	0	200 lb/A
	sodium, ppm		potassium, ppm		ratio	
Central core	231	110	1089	1284	0.20	0.10
Vascular 1	186	111	1002	1302	0.19	0.09
Vascular 2	178	108	991	1302	0.19	0.09
Parenchyma 1	573	311	1324	3192	0.46	0.10
Parenchyma 2	495	287	1105	2564	0.46	0.12
Outer rings	116	98	948	1165	0.14	0.09
Crown pith	919	349	5357	7172	0.25	0.06
Crown vascular	153	102	1343	1618	0.13	0.07
	LSD (0.05) = 96		LSD (0.05) = 413		LSD (0.05) = 0.08	
	n = 64		n = 64		n = 64	

SUGARBEET RESEARCH

1977 Report

Section E

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Farmers and Manufacturers Beet Sugar Association
American Crystal Sugar Company
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Michigan Sugar Company
Monitor Sugar Division
Michigan Agricultural Experiment Station

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CONTENTS

Evaluation of Sugarbeet Hybrids

G. J. Hogaboam

The evaluation program for 1977 was cooperative with the Farmers & Manufacturers Beet Sugar Association and its member companies.

The sugar and purity analyses were conducted by M. G. Frakes, Director of Research, Michigan Sugar Company. The percent sucrose, percent clear juice purity, and recoverable white sugar per ton were determined according to "A rapid and practical method of determining extractable white sugar, as may be applied to the evaluation of agronomic practices and grower deliveries in the sugarbeet industry", by S. T. Dexter, M. G. Frakes, and F. W. Snyder, as published in the Journal of the American Society of Sugar Beet Technologists, Vol. 14, No. 5.

Twenty-eight USDA hybrids were included in a 36 variety test conducted at Ottawa, Ohio, Vassar, Michigan and Saginaw, Michigan. The days between planting and harvest were 166, 197, and 196 respectively. The results of these tests are given individually and the three were combined as performance in percent of the general mean.

Experiment 7021364 F & M - USDA Nursery Hybrid Trial, James Schroeder Farm, Ottawa, Ohio

Seed Number					Pounds RWS/A	Tons/A	Pounds RWS/T	% Sucrose	% CJP	Beets /100'
SP75572-01	x			SP6822-0	6286	27.84	226.7	13.85	93.31	98.8
SP75576-01	x			SP6822-0	6541	26.92	240.0	14.38	94.36	105.8
SP75578-01	x			SP6822-0	6933 5	29.01	237.1	14.29	93.93	94.4
SP74566-02	x	SP74513-0	x	SP6822-0	6314	26.52	237.4	14.37	93.65	97.2
SP74564-01	x	SP74513-0	x	SP6822-0	6394	26.39	241.3	14.52	93.93	106.9
SP74572-01	x	SP74513-0	x	SP6822-0	6578	27.10	243.2	14.64	93.93	106.6
SP74682-01	x	SP74513-0	x	SP6822-0	6371	25.53	250.0	14.92	94.28	100.8
SP74564-01	x	SP71527-0	x	SP6822-0	6359	26.48	239.3	14.44	93.76	103.0
FC506ms	x	SP71527-0	x	SP6822-0	6338	25.63	246.3	14.88	93.69	101.3
UI1861ms	x	UI12166	x	SP6822-0	6478	28.02	233.2	14.10	93.74	100.2
UI104366B	x	SP74550-0	x	SP6822-0	6658	26.78	248.0	14.84	94.17	92.2-
SP74566-02	x	SP74550-0	x	SP6822-0	-6746 10	28.13	239.1	14.33	94.20	103.6
SP74564-01	x	SP74550-0	x	SP6822-0	6329	25.99	244.2	14.68	93.92	99.7
UI101967	x	SP74550-0	x	SP6822-0	7052 3	28.00	252.4+ 2	15.04+	94.25	99.4
UI102167	x	SP74550-0	x	SP6822-0	-6789 8	26.86	252.3+ 3	15.11+	94.08	100.2
SP70557-01	x	EL36	x	SP6822-0	6812 7	28.33	241.4	14.43	94.27	99.7
SP74513-01	x	EL36	x	SP6822-0	7070 2	29.58	236.7	14.35	93.74	103.8
SP71527-01	x	EL36	x	SP6822-0	6701	27.82	240.3	14.40	94.32	103.8
SP74682-01	x	EL36	x	SP6822-0	6452	29.00	222.5-	13.53-	93.79	105.2
SL129ms	x	UI12161P	x	SP6822-0	-6768 9	27.74	242.7	14.55	94.14	105.2
SP74564-01	x	EL36	x	SP6822-0	6556	28.66	229.8	14.07	93.02-	104.1
SP74563-01	x	EL36	x	SP6822-0	6481	27.99	229.9	13.94	93.69	98.3
SP74566-01	x	EL36	x	SP6822-0	6527	28.93	221.5-	13.62-	93.20-	98.3
SP74572-03	x	EL36	x	SP6822-0	6629	28.66	231.6	14.09	93.42	103.6
UI100467-5	x	EL36	x	SP6822-0	6935 4	30.68+	226.7	13.84	93.28	96.6
UI106666-10	x	EL36	x	SP6822-0	6848 6	29.91	230.4	14.01	93.39	92.2-
UI102167E	x	EL36	x	EL40	7501 1	30.07	249.4	14.96	94.04	102.5
SP71550-01			x	SP6822-0	6460	25.45	255.3+ 1	15.20+	94.34	94.1
GENERAL MEAN (GM)					6707.3	28.14	238.4	14.42	93.71	98.7
LSD 5%					N.S.	2.81	13.9	.68	.67	9.7
Coefficient of variation					10.0	8.64	5.03	0.10	0.62	8.53

- = Significantly under (+ = significantly over) performance of US H20 at the 5% level

Performance of US H20 numbers (underlined) were averaged for use in comparisons.

Experiment 7023365 F & M - USDA Nursery Hybrid Trial, Koeppendoerfer Farm, Vassar, Michigan

Seed Number	Pounds RWS/A	Tons/A	Pounds RWS/T	% Sucrose	% CJP	Beets /100'
SP75572-01 x SP6822-0	7718	35.28	219.5-	13.96-	91.21-	92.1
SP75576-01 x SP6822-0	6978-	27.80-	250.0	15.21	93.35	76.7-
SP75578-01 x SP6822-0	8185	33.63	245.1	14.99	92.92	91.5
SP74566-02 x SP74513-0 x SP6822-0	7997	33.24	243.5	15.02	92.46	89.8
SP74564-01 x SP74513-0 x SP6822-0	8509	33.89	252.2	15.46	92.79	98.6
SP74572-01 x SP74513-0 x SP6822-0	7913	32.14	246.4	15.13	92.69	97.4
SP74682-01 x SP74513-0 x SP6822-0	8455	33.55	252.9	15.45	92.87	100.9
SP74564-01 x SP71527-0 x SP6822-0	8359	32.58	260.1	15.62	93.71	99.1
FC506ms x SP71527-0 x SP6822-0	8690	34.55	254.2	15.45	93.18	108.4
UI1861ms x UI12166 x SP6822-0	8358	34.91	240.9	14.95	92.26	94.6
UI104366B x SP74550-0 x SP6822-0	7846	33.17	235.7	14.67	92.21	98.0
SP74566-02 x SP74550-0 x SP6822-0	7670-	30.47-	251.1	15.44	92.83	97.5
SP74564-01 x SP74550-0 x SP6822-0	8040	31.95	250.0	15.28	93.11	96.8
UI101967 x SP74550-0 x SP6822-0	8317	32.94	252.0	15.38	93.14	105.7
UI102167 x SP74550-0 x SP6822-0	8406	34.37	245.1	15.11	92.55	101.8
SP70557-01 x EL36 x SP6822-0	8563	33.85	253.1	15.37	93.33	97.4
SP74513-01 x EL36 x SP6822-0	7822	32.69	239.0	14.86	92.28	99.3
SP71527-01 x EL36 x SP6822-0	8395	34.02	248.0	15.15	92.94	102.8
SP74682-01 x EL36 x SP6822-0	7991	34.78	229.6-	14.39	91.94	101.8
SL129ms x UI12161P x SP6822-0	8962	34.62	258.0	15.56	93.66	99.1
SP74564-01 x EL36 x SP6822-0	8336	34.08	242.7	14.87	93.10	96.2
SP74563-01 x EL36 x SP6822-0	8040	33.99	237.3	14.68	92.48	99.7
SP74566-01 x EL36 x SP6822-0	7891	33.29	238.8	14.67	92.85	94.3
SP74572-03 x EL36 x SP6822-0	7339-	33.50	220.4-	13.94	91.36-	97.5
UI100467-5 x EL36 x SP6822-0	8175	34.49	238.1	14.75	92.39	92.8
UI106666-10 x EL36 x SP6822-0	8749	36.53	238.9	14.76	92.50	93.5
UI102167E x EL36 x EL40	8790	34.31	255.6	15.59	93.09	87.4
SP71550-01 x SP6822-0	7736	29.50-	262.0	15.93	93.32	79.4-
GENERAL MEAN (GM)	8038	33.10	243.2	15.00	92.61	92.9
LSD 5%	984	3.31	19.0	.81	1.33	12.1
Coefficient of variation	10.59	8.66	6.75	4.70	1.24	11.29

- = Significantly under (+ = significantly over) performance of US H20 at the 5% level.

Performance of US H20 numbers (underlined) were averaged for use in comparisons.

Experiment 7025363 F & M - USDA Nursery Hybrid Trial, B & B Farm, Saginaw, Michigan (1977)

Seed Number	Pounds RWS/A	Tons/A	Pounds RWS/T	% Sucrose	% CJP	Beets /100'
SP75572-01 x SP6822-0	6827-	26.34	257.0-	15.64-	93.21-	73.8-
SP75576-01 x SP6822-0	7197	25.82	278.4	16.46	94.52	84.5
SP75578-01 x SP6822-0	7340	27.35	269.4	16.02	94.29	79.0
SP74566-02 x SP74513-0 x SP6822-0	6932	25.05-	274.9	16.37	94.12	77.2
SP74564-01 x SP74513-0 x SP6822-0	7661	28.24	270.9	16.22	93.88	93.1
SP74572-01 x SP74513-0 x SP6822-0	7181	25.95	277.1	16.48	94.24	73.9-
SP74682-01 x SP74513-0 x SP6822-0	7015	26.24	268.5	16.07	94.01	80.5
SP74564-01 x SP71527-0 x SP6822-0	7002	25.59	272.6	16.22	94.25	83.5
FC506ms x SP71527-0 x SP6822-0	7444	27.10	273.3	16.28	94.19	88.4
UI1861ms x UI12166 x SP6822-0	7534	27.33	276.5	16.39	94.44	89.2
UI104366B x SP74550-0 x SP6822-0	7911	29.12	273.5	16.22	94.40	86.7
SP74566-02 x SP74550-0 x SP6822-0	7191	26.45	271.0	16.17	94.05	84.6
SP74564-01 x SP74550-0 x SP6822-0	7384	26.97	274.2	16.38	94.01	89.4
UI101967 x SP74550-0 x SP6822-0	7758	28.03	277.1	16.34	94.63	85.9
UI102167 x SP74550-0 x SP6822-0	8337	29.71	282.1	16.68	94.50	89.0
SP70557-01 x EL36 x SP6822-0	7864	29.04	270.5	15.98	94.71	87.8
SP74513-01 x EL36 x SP6822-0	7762	28.50	272.9	16.16	94.56	88.2
SP71527-01 x EL36 x SP6822-0	7592	28.18	270.2	16.15	94.02	90.4
SP74682-01 x EL36 x SP6822-0	7868	30.41	260.4-	15.71-	93.63-	83.8
SL129ms x UI12161P x SP6822-0	8108	29.69	274.3	16.26	94.45	82.9
SP74564-01 x EL36 x SP6822-0	8119	31.17	261.3-	15.80	93.48-	89.5
SP74563-01 x EL36 x SP6822-0	8246	31.22	263.2-	15.75-	93.94	88.3
SP74566-01 x EL36 x SP6822-0	7410	27.64	268.1	16.11	93.78	80.1
SP74572-03 x EL36 x SP6822-0	7068	26.47	268.2	16.08	93.91	83.5
UI100467-5 x EL36 x SP6822-0	7126	26.91	261.9-	15.69-	93.95	84.4
UI106666-10 x EL36 x SP6822-0	8278	31.22	266.1	15.95	93.88	86.2
UI102167E x EL36 x EL40	6870-	25.02-	276.2	16.45	94.18	72.8-
SP71550-01 x SP6822-0	6606-	23.59-	280.2	16.71	94.07	68.5-
GENERAL MEAN (GM)	7410	27.58	269.1	16.13	93.89	81.2
LSD 5%	915	3.29	12.2	.56	.76	10.0
Coefficient of variation	10.7	10.32	3.93	3.00	0.70	10.65

- = Significantly under (+ = significantly over) performance of US H20 at the 5% level.
Performance of US H20 numbers (underlined) were averaged for use in comparison.

Experiments at Ottawa, Ohio, Vassar, Michigan, and Saginaw, Michigan combined

PERFORMANCE IN PERCENT OF GENERAL MEAN

Seed Number	Pounds RWS/A	Tons/A	Pounds RWS/T	% Sucrose	% CJP	Beets /100'
SP75572-01 x SP6822-0	93.96-	100.36	93.62-	95.40-	99.11-	96.8
SP75576-01 x SP6822-0	93.83-	91.11-	102.32	101.07	100.72	98.0
SP75578-01 x SP6822-0	101.42	101.31	100.12	99.49	100.34	97.2
SP74566-02 x SP74513-0 x SP6822-0	95.73	95.17	100.63	100.43	100.01	96.7
SP74564-01 x SP74513-0 x SP6822-0	101.53	99.52	101.87	101.48	100.14	109.7
SP74572-01 x SP74513-0 x SP6822-0	97.81	95.84	102.09	101.54	100.23	101.3
SP74682-01 x SP74513-0 x SP6822-0	98.28	95.76	102.90	102.06	100.34	103.3
SP74564-01 x SP71527-0 x SP6822-0	97.77	95.12	102.88	101.64	100.54	104.7
FC506ms x SP71527-0 x SP6822-0	101.03	97.92	103.15	102.39	100.31	109.4
UI1861ms x UI12166 x SP6822-0	100.75	101.39	99.89	99.71	100.08	104.4
UI104366B x SP74550-0 x SP6822-0	101.22	100.32	100.87	100.46	100.20	101.9
SP74566-02 x SP74550-0 x SP6822-0	97.69	95.98	101.43	100.88	100.31	104.7
SP74564-01 x SP74550-0 x SP6822-0	99.17	96.56	102.66	101.99	100.31	108.3
UI101967 x SP74550-0 x SP6822-0	103.29	99.23	103.88	102.54	100.63	103.6
UI102167 x SP74550-0 x SP6822-0	106.11 3	102.36	103.82	102.99	100.33	106.9
SP70557-01 x EL36 x SP6822-0	104.74 4	102.76	101.96	100.55	100.75	104.7
SP74513-01 x EL36 x SP6822-0	102.50	102.41	99.67	99.62	100.13	106.9
SP71527-01 x EL36 x SP6822-0	102.27	101.29	101.05	100.37	100.38	109.1
SP74682-01 x EL36 x SP6822-0	100.60	106.15	94.84-	95.74-	99.70-	106.5
SL129ms x UI12161P x SP6822-0	107.27 1	103.62	103.29	101.86	100.73	105.1
SP74564-01 x EL36 x SP6822-0	103.68	105.95	97.77	98.26	99.79	106.5
SP74563-01 x EL36 x SP6822-0	102.65	105.14	97.27-	97.44-	99.97	105.3
SP74566-01 x EL36 x SP6822-0	98.50	101.21	96.92-	97.41-	99.87	99.9
SP74572-03 x EL36 x SP6822-0	95.18-	99.69	95.82-	96.80-	99.46-	104.2
UI100467-5 x EL36 x SP6822-0	100.43	103.61	96.78-	97.20-	99.79	100.6
UI106666-10 x EL36 x SP6822-0	107.56 1	1[illegible].96	97.93	98.19	99.84	100.1
UI102167E x EL36 x EL40	104.64	1[illegible]2	104.12	103.23	100.39	95.8-
SP71550-01 x SP6822-0	93.90-	8[illegible].38-	106.33+	105.09+	100.54	88.4-
GENERAL MEAN (GM)	100.00	10[illegible]	100.00	100.00	100.00	100.00
LSD 5% as % of GM	8.56		3.86	2.91	.64	8.88
Coefficient of variation	5.24		2.36	1.78	0.39	5.44

\- = Significantly under (+ = significantly over) performance of US H20 at the 5% level

Performance of US H20 numbers (underlined) were averaged for use in comparison.

Sugarbeet Disease Investigations

C.L. Schneider

1. Effect of cropping sequence on Rhizoctonia root rot. - This study has been conducted since 1973 at the Saginaw Valley Bean and Beet Research Farm in cooperation with D.R. Christensen, Michigan State University, Department of Crop and Soil Science. The four cropping sequences and rotation periods are as follows: No. 1 (c-sb; c-c-sb, c-c-c-sb); No 2 (c-b-sb, c-c-b-sb); No. 3 (b-sb, b-b-sb, c-b-b-sb); No. 4 (o-b-sb, o-a-b-sb).[1/] Each sugarbeet plot comprised 8 rows, 66 ft. long. The experiment was divided into 4 blocks which retained the same position in the field each year.

Incidence of root rot through natural occurrence of *Rhizoctonia solani* was relatively low but varied significantly from season to season with a minimum of 0.8% in 1974 and a maximum of 3.9% in 1975. There was no significant effect due to rotation period. The root rot incidence (5 year average) with each cropping sequence was as follows; No. 1=1.0%; No. 2=1.9%; No. 3=2.9%; No. 4=2.3%. The difference between No. 1 and No. 3 is significant. There was also a significant difference in 5 year average root rot incidence between Block I (1.3%) and Block IV (3.1%) indicating that some areas in a field may consistently show higher degree of root rot than other areas.

2. Test of fungicides for control of Rhizoctonia root rot. - Plots of commercial sugarbeet variety, US-H20, each comprising one 5-m row, were planted on 10 May. Dried barley grain inoculum of *R. solani* was applied along the plant rows and into the leaf whorls on 6 June. Fungicide sprays were applied either once, on 5 June, or twice, on 5 June and 21 July. Treatments were applied in a 20-cm band along the row with a hand-operated, CO_2-powered sprayer at 15 PSI and at the rate of 561 liters/ha (60 gal/acre) of water. Disease symptoms were evident in most plots within 10 days after inoculation. Disease intensity in each plot was estimated on 27 July and 26 August. On 7 September mean percent root rot in each harvested plot was determined by rating each inoculated plant according to a disease symptom index ranging from 0 (no symptoms) to 4 (dead), summating scores and dividing by the product of total plants inoculated X 4 (highest rating).

Disease intensity in untreated control plots was extremely severe. Treatments differed significantly in degree of control afforded. (Table 1) The following treatments reduced root rot damage significantly below that of the untreated control: Bayleton 50 W (1.5 and 2.0 lb/acre), Benlate 50 W (1.5 l.b/acre) ,and Du-Ter 47 W (10 oz/acre). One early application was as effective as an early plus a late application. The use of an extender-sticker spreader with Bayleton 50 W, Benlate 50 W, Du-Ter 47.5 W, and Terraclor 75 W did not result in increased efficacy.

3. Tests of fungicides for control of Cercospora leaf spot. - Plots of commercial sugarbeet variety US-H20, each comprising two 5-m rows, were planted on 20 May. Interspaced between each plot was a row of red garden beets, highly susceptible to leaf spot. Dried and ground sugarbeet leaves, infested with *C. beticola* were applied as inoculum to the foliage of the garden beets on 30 June. The garden beets developed leaf spot symptoms within two weeks after inoculation. By the end of July incipient symptoms had been noted in all of the sugarbeet plots. Commencing on 3 August, treatments were applied either on a 14-day schedule, 3 times, or on a 21-day schedule, twice. Treatments were applied as foliar sprays with a hand-operated, CO_2 - powered sprayer at 15 PSI and at the rate of 561 liters/ha (60 gal/acre) of water.

1/ c=corn; sb=sugarbeet; b=navy beans; o=oats; a=alfalfa.

Plots were rated according to disease severity on 12 September when disease incidence was 100%. All of the treatments reduced disease severity significantly below that of the untreated control. (Table 2). Treatments differed significantly in efficacy. Most treatments comprising systemic fungicides, alone or in combination with protective-type fungicides, provided a greater degree of control than did protective-type fungicides alone.

4. Seed treatments tested for control of *Phoma betae* - F and M seed lots produced in Oregon in 1976 showed high incidence of Phoma infection. Degree of infection among 16 lots submitted to this laboratory ranged from 17 to 89%, and averaged 51%. In laboratory emergence tests, high incidence of Phoma significantlyreduced emergence.

Twenty-seven fungicide seed treatments were evaluated for efficacy in reducing Phoma infection. Seed of F and M commercial variety (Lot 6167), heavily infected with *P. betae*, was treated with each fungicide in one or more of the following ways: dust, mist, liquid concentrate, slurry, steep. Seed samples of each treatment were plated out on water agar to determine degree of Phoma infestation. Some of the treatments were also included in a field test, planted 24 May in soil naturally infested with seedling blight fungi.

The following treatments reduced Phoma seed infection below that of the untreated control: Arasan 50 W, Bayleton 2ST, BTS 40-542 DP and WP, Dexon 70 W + Arasan 50 W, ME-1-44 LSP, Sul Flo L, and Terraclor 75 W. In the field test the following treatments resulted in seedling stands significantly higher than the standard Dexon 70 W (2 oz/cwt) control treatment: Benlate 50 W (1.6 oz), Dexon 70 W (4.0 oz), and Terracoat L-21. The results of the field test indicate that soil damping-off organisms probably affected seedling stands more than seed-borne Phoma did. The latter is dependent on cool temperature for seedling blight development, and inasmuch as the experiment was planted relatively late, warmer temperature prevailed. Seedling phytotoxicity was associated with Bayleton 50 W at the 1.6 and 3.2 fl oz/cwt rates employed.

Table 1. Test of fungicides to control Rhizoctonia root rot of sugarbeet at East Lansing Michigan in 1977.

Treatment and rate ofproduct/acre (ha) in 8-in (20.3 cm) band	No. applications 1)	Disease index 2)3)4) 27 July	Disease index 2)3)4) 26 August	Pct. root rot 3)4) 7 Sept.
Bayleton 50 W, 1.0 lb (1.12 kg)	2	2.3 abcd	5.7 bcde	61.3 bc
Bayleton 50 W, 1.0 lb (1.12 kg) + Nu-Film 17 5)	2	3.2 bcde	6.5 bcdef	74.2 bcde
Bayleton 50 W, 1.5 lb (1.68 kg)	2	1.7 ab	5.2 abc	57.2 ab
Bayleton 50 W, 2.0 lb (2.24 kg)	1	1.8 ab	5.0 abc	61.2 bc
Bayleton 50 W, 2.0 lb (2.24 kg)	2	2.3 abcd	5.3 abcd	56.0 ab
Benlate 50 W, 8 oz (0.56 kg)	2	2.0 abc	5.5 abcde	66.2 bcd
Benlate 50 W, 8 oz (0.56 kg) + Nu-Film 17 5)	2	2.8 abcd	5.5 abcde	78.2 bcde
Benlate 50 W, 12 oz (0.84 kg)	2	1.8 abc	4.5ab	56.5 ab
BTS 40 542 25 W, 2.0 lb (2.24 kg)	2	5.2 f	8.3 f	84.8 de
BTS 40 542 25 W, 3.0 lb (3.36 kg)	2	3.2 bcde	7.2 ef	85.5 de
BTS 40 542 25 W, 4.0 lb (4.48 kg)	2	5.0 ef	8.5 f	90.8 e
Bravo 6 F, 1.5 pints (1.75 liters)	2	4.8 ef	8.2 f	87.5 de
Bravo 6 F, 1.5 pints (1.75 liters) + Nu-Film17 5)	2	4.7 ef	7.8 ef	87.8 de
Bravo 6 F, 1.0 qt (2.34 liters)	1	1.2 a	4.8 abc	67.0 bcde
Bravo 6F, 1.0 qt (2.34 liters)	2	2.8 abcd	6.5 bcdef	74.3 bcde
DPX-112-2 80 W, 1.5 lb (1.68 kg)	2	2.3 abcd	7.7 ef	87.2 de
DPX-112-2 80 W, 2.0 lb (2.24 kg)	2	2.0 abc	5.5 abcde	73.2 bcde
Du-Ter 47.5 W, 10 oz (0.70 kg)	2	2.8 abcd	3.3 a	38.8 a
Du-Ter 47.5 W, 10 oz (0.70 kg) + Nu-Film 17 5)	2	1.8 abc	4.7 ab	65.2 bcd
Mertect 340 F, 3.8 fl. oz (0.28 liters)	2	4.8 ef	7.5 def	80.8 cde
Mertect 340 F, 7.6 fl. oz (0.56 liters)	2	4.8 ef	8.7 f	87.0 de
Terraclor 75 W, 2.0 lb (2.24 kg)	1	3.8 def	8.0 f	91.0 e
Terraclor 75 W, 2.0 lb (2.24 kg)	2	3.5 cde	5.7 bcde	69.5 bcde
Terraclor 75 W, 2.0 lb (2.24 kg) + Nu-Film 17 5)	2	4.8 ef	7.7 ef	79.2 bcde
Vitavax 75 W, 2.0 lb (2.24 kg)	1	2.5 abcd	7.7 ef	79.2 bcde
Vitavax 75 W, 2.0 lb (2.24 kg)	2	2.5 abcd	6.7 bcdef	83.3 cde
Untreated control	0	4.2	7.7	82.7
L.S.D. (.05) to compare treatments with control		1.5	2.0	19.5
C.V. (%)		40.5	27.1	22.8

1) 1 = Application on 5 June, one day before inoculation. 2 = Application on 5 June and 21 July.
2) Disease index = estimate of amount of diseased and dead plants/plot from 0 (non) to 10 (100 pct).
3) Small letters indicate Duncan's multiple range grouping of trtm that do not differ significantly at the 5% level.
4) Data expressed as means of six replicated plots.
5) An extender sticker-spreader applied at 4 oz/acre (292 ml/ha).

Table 2. - Test of fungicides to control Cercospora leaf spot of sugarbeet at East Lansing, Michigan in 1977.

Treatment and rate of product/acre (ha).	Spray schedule (days)	Leaf spot[1] severity index
1 Benlate 50 W, 4 oz (0.28 kg)	21	1.7 abc
2 Benlate 50 W, 4 oz (0.28 kg) + oil[2]	21	1.0 a
3 Benlate 50 W, 4 oz (0.28 kg)	14	1.0 a
4 BTS 40 542 25 W, 2.0 lb (2.24 kg)	14	2.7 efgh
5 BTS 40 542 25 W, 3.0 lb (3.36 kg)	14	3.0 ghi
6 BTS 40 542 25 W, 4.0lb (4.48 kg)	14	3.5 i
7 Bravo 6 F, 1.5 pints (1.75 liters)	14	3.2 hi
8 Bravo 6 F, 1.0 qt (2.34 liters)	14	3.2 hi
9 Bravo 75 W, 1.0 qt (2.34 liters)	14	2.7 efgh
10 Difolatan 4 F, 1.0 qt (2.34 liters)	14	2.5 defg
11 Difolatan 4 F, 2.0 qt (4.68 liters)	14	2.8 fghi
12 Difolatan 4 F, 1.0 pint (1.17 liters) + Orthocide 50 W, 4.0 lb (4.48 kg)	14	2.7 efgh
13 Difolatan 4 F, 1.0 qt (2.34 liters) + Orthocide 50 W, 4.0 lb (4.48 kg)	14	2.7 efgh
14 DPX-110 86 W, 3.0 lb (3.36 kg)	21	1.2 ab
15 DPX-112-2 80 W, 1.5 lb (1.68 kg)	21	1.5 abc
16 DPX-112-2 80 W, 2.0 lb (2.24 kg)	21	1.7 abc
17 Du-Ter 47.5 W, 4 oz (0.28 kg)	14	2.5 defg
18 Du-Ter 47.5 W, 10 oz (0.70 kg)	14	2.3 defg
19 Mertect 340-F, 2 fl oz (146 ml)	21	2.2 cdef
20 Mertect 340-F, 4 fl oz (292 ml)	21	2.2 cdef
21 Mertect 340-F, 12 fl oz (877 ml)	21	1.8 bcd
22 Mertect 340 F, 2 fl oz (146 ml) + oil[2]	21	2.2 cdef
23 Mertect 340-F, 2 fl oz (146 ml) + Nu-Film 17[3]	21	2.3 defg
24 Mertect 340-F,4 fl oz (292 ml) + oil[2]	21	2.0 cde
25 Mertect 340-F, 4 fl oz (292 mzl) + Nu-Film 17[3]	21	2.2 cdef
26 Orthocide 50 W, 4.0 lb (4.48 kg)	14	3.2 hi
27 Orthocide 50 W, 8.0 lb (8.96 kg)	14	2.7 efgh
28 Untreated control		4.3
L.S.D. (.05) between treatments and control		0.7
C.V. (%)		19.2

1) Index: 1 = (no symptoms), 9 = (complete defoliation). Small letters indicated Duncan's multiple range grouping of treatments that do not differ significantly at the 5% level.
2) A 70-sec spray oil.
3) An extender sticker-spread applied at 4 oz/acre (292 ml/ha).

Table 3. - Results of sugarbeet seed treatment tests at East Lansing in 1977 to control <u>Phoma betae</u>.

Treatment and rate of product/cwt (100 kg)	Type of Treatment[1/]	Pct. of seed[2/] infected with Phoma	Field test[3/] No. plants/plot
Arasan 50 W, 3.2 oz (200 g)	Sl	66.0 *	39.5 cde
Arasan 50 W, 0.5%	St	58.4 *	-
Bayleton 2 ST, 1.6 fl oz (104 ml)	L	77.1	23.8 b
Bayleton 2 ST, 3.2 fl oz (209 ml)	L	65.7 *	9.3 a
Benlate 50 W, 1.6 oz (100 g)	Sl	89.4	42.2 e
Benlate 50 W, 3.2 oz (200 g)	Sl	88.9	32.5 cde
BTS 40 542 25 DP, 4.0 oz (250 g)	D	15.8 *	39.7 cde
BTS 40 542 25 DP, 4.0 oz (250 g)	Sl	0.8 *	38.7 cde
BTS 40 542 25 WP, 4.0 oz (250 g) 4)	Sl	0 *	-
Dexon 70 W, 2.0 oz (125 g)	Sl	74.4	30.7 bcd [4/]
Dexon 70 W, 4.0 oz (250 g)	Sl	87.2	43.2 e
Dexon 70 W, + Arasan 50 W	M	71.3 *	-
Dexon 70 W, 2.0 oz (125 g) + Terraclor 75 W, 2.0 oz (125 g)	Sl	84.2	-
DPX-14-2 75W, 2.4 oz (150 g)	Sl	82.9	31.8
DPX-14-2 75 W, 4.0 oz (250 g)	Sl	79.4	39.5 bcde
DPX-1991-T, 4.0 oz (250 g)	Sl	74.7	-
Me-1-44 LSP, 2.0 fl. oz (130 ml)	L	64.3 *	35.0 cde
Me-1-44 LSP, 4.0 fl oz (261 ml)	L	59.9 *	41.2 cde
Mertect 30 LSP, 4.0 fl oz (261 ml)	L	85.7	23.2 b
Mertect 30 LSP 8.0 fl oz (522 ml)	L	84.2	30.3 bc
Mertect 30 LSP 12.0 fl oz (782 ml)	L	83.6	37.0 cde
Sul-Co-Flo, L, 5.3 fl oz (346 ml)	L	87.3	37.0 cde
Sul-Flo, L, 5.3 fl oz (346 ml)	L	62.7	-
Terraclor 75 W, 2.0 oz (125 g)	Sl	44.4 *	34.8 cde
Terraclor 75 W, 4.0 oz (250 g)	Sl	31.9 *	41.3 de
Terracoat L21, 6.0 oz. (391 ml)	L	57.0 *	- -
Terracoat L21, 12 oz. (782 ml)	L	1.6 *	- -
Untreated control	None	88.5	-

1/ D = dust; M = mist; L = liquid concentrate; Sl = slurry; St = steep.

2/ Results are based on tests comprising 8-20 water agar plates each containing 7 seed balls. Treatments differing significantly from the untreated control at the 5% level according to the t-test, are designated: *

3/ Results are expressed as means 6 one-row plots, each 5-m long, small letters indicate Duncan's multiple range grouping of treatments that do not differ significantly at the 5% level.

4/ Control treatment in field test.

Abstracts of Papers Published in 1977

1. Schneider, C. L. and G. R. Safir. 1976. Use of infrared aerial photography to evaluate disease severity in sugarbeet exposed to blackroot and to crown rot diseases. Proc. Am. Phytopathol. Soc. 3: 245 (Abstract) (Published Feb. 1977).

Enlarged color prints (1:320-780 scale) were made from IR aerial photographs of blackroot (*Aphanomyces cochlioides*) and crown rot (*Rhizoctonia solani*) nurseries in 1974 and 1975. Each 5-m plot on a print was indexed on a color scale of 1 (blue) to 10 (red) indicating relative foliage mass of nil to luxuriant, respectively. IR photo ratings correlated significantly with disease severity ratings (r ranged from 0.61-0.86).

2. Schneider, C. L., H. S. Potter, and D. L. Reichard. 1976. Tests with fungicides to control Rhizoctonia crown rot of sugarbeet. J. Am. Soc. Sugar Beet Technol. 19: 150-156 (Published April 1977).

In a series of tests in field plots artificially infested with *Rhizoctonia solani*, fungicides were sprayed at various rates and schedules into crowns and at the bases of plants. Treatments showing potential for reducing disease incidence include benomyl, carboxin, chlorothalonil, PCNB, and TPTH. However, inconsistent control with these treatments indicates a need for improved methods of application, including the use of spray adjuvants.

3. Schneider, C. L. and G. J. Hogaboam. 1977. New occurrences of powdery mildew and curly top in sugarbeet in Michigan in 1975. Plant Dis. Reptr. 61: 88-89.

In 1975, powdery mildew was reported for the first time on sugarbeet in Michigan. An epiphytotic, obviously associated with the 1974 and 1975 outbreaks throughout western USA areas, developed late in the growing season throughout Michigan sugarbeet areas. There was no evidence of serious economic loss. A few plants with curly top were observed in two experimental fields in Ingham County. This occurrence is the first to be reported from the eastern area since 1958.

4. Schneider, C. L., R. L. Sims, and H. S. Potter. 1977. Report of 1975 test of fungicides to control Cercospora leaf spot disease of sugarbeet. *In* Fungicide-Nematicide Tests, Vol. 32: 74-75. (Abstract with table).

In a test of 16 treatments, the disease severity rating of untreated control = 5.0, based on an index from 0 (no disease) to 9 (complete defoliation). All treatments, including basal applications of Benlate (0.56 kg/ha) and Mertect (0.86 l/ha), showed significantly lower disease severity than the untreated control. Benlate 50W (0.56 kg/ha) and DPX-10 50W (0.56 kg/ha) were rated superior.

BREEDING SUGARBEETS FOR RESISTANCE TO BLACK ROOT AND LEAF SPOT

G. E. Coe

Research work on sugarbeets at the Agricultural Research Center, Beltsville, Maryland, is directed toward varietal improvement of sugarbeets resistant to Aphanomyces black root and Cercospora leaf spot, important diseases in eastern United States. Only a small fraction (121) of the breeding lines were tested for black root in the winter of 1976-77 because the roof of the greenhouse was being replaced.

The time ordinarily spent on black root tests was utilized in running cold temperature germination tests in cold storage rooms and seedling vigor tests in growth chambers.

Cold Temperature Germination Tests

The cold temperature germination tests were run in potting soil in 6 inch saucers at 52°F. Approximately 440 individual plant progenies were tested. Under these conditions seedlings began to emerge from 7 to 15 days after planting. In the winter of 1975-76, 64 early-emerging multigerm seedlings were selected from among 14 parent lines with good cold temperature germination performance. Progeny of these 64 selected seedlings were compared with their parental sorts in cold temperature germination tests in 1977. The temperature was maintained at 48°F in these tests. The results are presented in Table 1.

TABLE 1. Time required for seedling emergence of selected progeny and their parental lines.

Parental Line Designation	Days Required for Seedling Emergence: Parental Line	Progenies
A	21	18, 18, 20, & 21
B	21	18, 18, 19, 20, & 20
C	21	18, 18, 19, 20, 20, 21, 21, & 21
D	24	19, 20, 20, 20, 21, 21, & 21
E	23	20, 21, 22, & 23
F	25	20, 21, & 23
G	25	19, 20, & 20
H	20	19, 19, 20, & 21
I	20	17, 17, 18, 18, 18, & 19
J	20	18, 19, & 19
K	21	17, 17, 19, 19, 19, & 19
L	22	19, 19, 20, 20, & 21
M	24	19, 19, 20, & 24
N	24	20, 20

It took almost twice as long for the seedlings to emerge in this test run at 48°F as it did for seedlings in tests conducted at 52°F. It should also be observed that the seed of the parental lines in this test were 2 years old compared to 1 month old seed of the progeny of the selected seedlings. Although the age of seed has some effect on the speed of germination, many of the progeny in this test are probably inherently more rapid in seedling emergence than the parental lines. Experiments conducted in England also indicate that it is possible to select for more rapid seedling emergence in cold temperatures.

In addition to this experiment all our multigerm breeding lines were screened for speedy cold temperature germination.

Selecting Seedlings for Increased Vigor in Growth Chambers

In 1977, some 1700 plants were grown in 6 inch pots in our growth chambers to select for vigorous seedlings with high root to leaf ratio. In addition, tests were conducted to determine if hybrids derived from vigorous seedlings selected in the growth chamber are superior to hybrids derived from the parental line from which they were selected. The first two experimental selections were out of SP6822-0 MM pollinator. One selection was based on vigorous seedlings having a relatively high root to leaf ratio and the second selection was based on vigorous seedlings with a relatively low root to shoot ratio. Progenies of these selections were numbered SP76256-00 and SP76255-00, respectively. As the seed increases were being made, male-sterile roots of SP74550-01 mm were included in the isolation plots to produce experimental hybrids. These two hybrids were compared with US H21, the "comparable" hybrid from the parental pollinator line, SP6822-0. These three hybrids were tested both in the growth chamber and the Beltsville nursery. Results of these tests are in Table 2.

TABLE 2. Comparison of hybrids derived from selected and unselected pollinator plants.

	Growth Chamber Test		Nursery Test (6 replications)	
Variety	Rt. Wt./ Leaf Wt.	Av. Rt. Wt. gms.	Av. Rt. Wt. T/Acre	Av. % Sucrose
SP74550-01 X SP76256-00	.067 a	1.65 a	24.95	15.0
SP74550-01 X SP76255-00	.060 b	1.49 ab	23.07	15.3
US H21	.059 b	1.39 b	23.68	15.3
			NS	NS
SP73514-01 X SP6822-0 (Selected)	.058 a	2.55 a		
SP73514-01 X SP6822-0 (Parental Line)	.053 a	1.89 b	Nursery tests to be conducted in 1978.	

Seedling taproots of SP74550-01 X SP76256-00 averaged 19 percent heavier than those of US H21 in the growth chamber test and this was significant at the 5 percent level; but this hybrid yielded only 5 percent more in the nursery trials and this was not significant. Tests by Snyder indicate that the difference in taproot size of the selected progeny and the unselected parental line is always somewhat greater in growth chamber tests than in field tests. If SP74550-01 X SP76256-00 is better in yield than US H21, our nursery test was not precise enough to demonstrate the difference. The hybrid SP73514-01 X SP6822-0(Selected) produced taproots in the growth chamber that were 35 percent heavier than taproots of the hybrid SP73514-01 X SP6822-0(Parental Line), Table 2. It should be possible to demonstrate a significant difference in yields of these two hybrids in the 1978 nursery tests.

Testing for Leaf Spot Resistance

A good leaf spot epidemic was obtained in the Beltsville nursery again in 1977. Results of this test are presented in Table 3.

TABLE 3. Results of leaf spot tests in 1977 Beltsville leaf spot nursery.

			Leaf Spot Rating*		
Experiment No.	Description	No. Lines Tested	Av. of Lines	US H20	US H21
1 & 11	MM lines from Beltsville	66	3.3	5.8	3.8
5	MM lines from E. Lansing	33	2.0	5.2	3.0
2 & 12	mm lines from Beltsville	48	3.0	5.9	5.0
2,3,4&8	mm lines from E. Lansing	91	3.2	5.4	4.1
4	mm Rhizoc. resistant lines from E. Lansing	20	3.3	6.0	5.0

*0 = No spots; 10 = All leaves dead.

The results are similar to those obtained for the last 3 or 4 years. Almost all the breeding lines were more resistant to Cercospora leaf spot than US H20 and US H21. Except for a few lines with slightly more susceptibility, nursery selections at Beltsville are now being made on the basis of root yield, percent sucrose, and quality.

Selecting for "Soil-Free" Roots

Estimations of the progress being made in the production of soil-free roots is difficult because of the differences in soil condition from year to year

at the time the roots are harvested. The soil was relatively dry this year when the "soil-free" roots stemming from crosses to garden beets were harvested. Hence, many progenies appeared to be relatively free from adhering soil. This made selecting somewhat more difficult than in previous years. The selected roots were clean and required no washing before being placed in storage. Sugar analyses and percent soluble non-sucrose solids were run on each of these 307 selected roots. The percent soluble non-sucrose constituents compare favorably with our regular breeding lines, but the percentage sucrose is too low for consideration for commercial use.

The ground was extremely wet when we harvested the smooth root selection from our sugarbeet lines that have not been crossed to globe shaped beets. There was a considerable amount of soil adhering to these roots making it difficult to find roots worthy of selection. These selections should be quite valuable with respect to freedom from soil. The selections were made without knowledge of the location of the check plots. Although roots were chosen from 85 percent of the plots, no roots were selected from the check plots because they obviously had more adhering soil than the smooth-root lines. This is indicative that previous selections have been effective.

Hybrids Produced from Male-Sterile Lines in *Beta maritima* Cytoplasm

Nine monogerm male-sterile lines derived from two *Beta maritima* plants having male-sterile cytoplasm were crossed with SP6922-0 MM pollinator. The hybrids from these crosses were tested in the Beltsville nursery in 1977. Data from this preliminary test are presented in Table 4.

TABLE 4. Beltsville nursery data from preliminary test of nine hybrids in *B. maritima* cytoplasm.

Variety	Leaf* Spot	Rts/ Acre	Root Wt. T/Acre	% Sucrose	% Raw Juice Apparent Purity
Hybrid 1	4.0	12,350	19.78	13.9	80.53
2	4.0	7,600	18.70	13.6	79.81
3	4.3	21,400	26.26	13.8	80.00
4	3.7	9,500	20.15	13.9	80.44
5	4.0	10,150	15.86	14.4	81.04
6	4.7	16,700	26.32	13.3	79.40
7	4.0	10,150	19.57	13.2	79.28
8	4.0	9,100	14.01	13.8	81.51
9	4.0	10,150	17.57	13.3	80.02
US H20	5.2	23,200	26.70	12.1	80.84
US H21	3.7	25,050	26.24	15.5	80.94

*0 = No spots; 10 = All leaves dead.

It is obvious that the stands of the hybrids ranged from rather poor to bad. This was due mostly to poor quality seed, but partly to black root disease. In spite of poor stands some interesting observations can be made. The leaf spot resistance of the hybrids was intermediate between US H20 and US H21 which is a commercially acceptable level of resistance. The root yields of the hybrids was more than might be expected with such poor stands. The sucrose percentages were as much as might be expected considering the degree of leaf spot infection and the size of the individual roots. The raw juice apparent purity was generally lower than that of the commercial hybrids, but two were as good. It appears that the monogerm male-sterile lines in *B. maritima* cytoplasm are worthy of further investigation.

Leaf Spot Resistance of New O-Types

Six new O-types were transplanted to the nursery in 1977. A moderately severe leaf spot epidemic occurred among these transplants. Powdery mildew was also present, but was not uniform across the plot. Therefore, the mildew resistance evaluations are probably of little value. Leaf spot and powdery mildew ratings are presented in Table 5.

TABLE 5. Leaf spot and powdery mildew ratings of monogerm O-types and their male-sterile companion lines.

Seed Number	Leaf Spot Rating[1]	Powdery Mildew Rating[2]
SP7622-0 (Resistant check)	2	2
SP76137. O-type	1	0
SP76137X1 MS	2	0
SP76138. O-type	1	0
SP76138X1 MS	1	0
SP76146. O-type	2	0
SP76146X1 MS	2	2
SP76156. O-type	3	2
SP76156X1 MS	2	2
SP76161. O-type	2	2
SP76161X1 MS	1	2
SP76165. O-type	1	0
SP76165X2 MS	1	1

1 0 = No spots; 10 = All leaves dead.
2 0 = No mildew; 10 = All plants severely infected.

All the new O-types appear to have sufficient leaf spot resistance to be usable. A few appear to be rather vigorous, but their combining ability must still be tested.